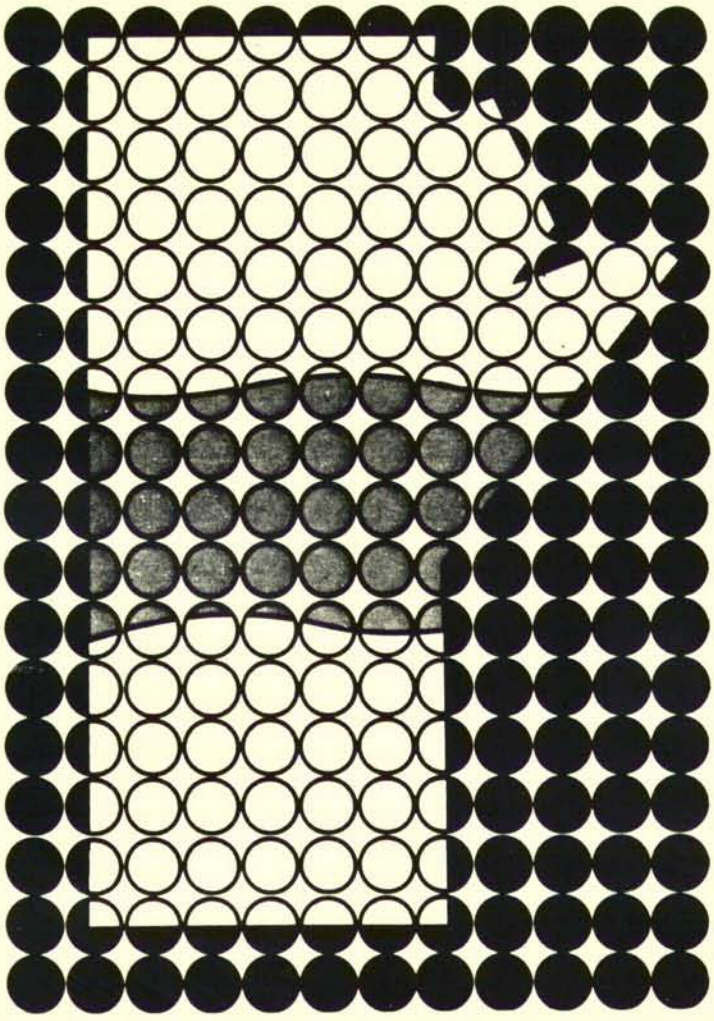


CANADA-MANITOBA Soil Survey

Soils of the Rural Municipality of Rhineland

Report D76

Government of Canada Gouvernement du Canada
Government of Manitoba Gouvernement du Manitoba

SOILS REPORT NO. D76 1991

SOILS OF THE RURAL MUNICIPALITY OF RHINELAND

by

Glenn Podolsky

CANADA-MANITOBA SOIL SURVEY

AGRICULTURE CANADA
MANITOBA DEPARTMENT OF AGRICULTURE
DEPARTMENT OF SOIL SCIENCE, UNIVERSITY OF MANITOBA

PREFACE

This interim report and map of the detailed field and laboratory study of the soils of the Rural Municipality of Rhineland is one in a new series of such soil survey reports covering special interest areas in southern Manitoba. These reports reflect the growing concern by various government agencies that support the Canada-Manitoba Soil Survey, that a knowledge of the development and distribution of the soils of Manitoba is the key to understanding their properties, behaviour and response to management. This concern requires that soils be described both in terms of their basic properties and the nature of the environmental setting in which they are found. Thus, when an area such as that in the R.M. of Rhineland study requires delineation of land of high or low value for crop production or for other uses, the basic reference document is an accurate and reliable soil map.

The land resource information included in this resurvey covers approximately 93 241 ha of land. It includes only a portion of the area covered in the reconnaissance survey of the Morris Map Sheet Area (Report No. 5, 1953). However, the projected more intensive use of the soils for agriculture and the growing competition for other uses of land in the area has created a need for more up-to-date, more accurate and more detailed soil information. The increased examination of soils in the field, the use of current aerial photography, the use of improved methods of studying soils in the laboratory and the accumulated knowledge of the properties and uses of soils over the years have all contributed to the additional information contained in this new series of reports and maps.

During the course of the resurvey of the project area, a significant volume of site specific data for the soils mapped in the area was generated, that for practical reasons cannot be included in this interim report. These data are currently being input into the Canada Soil Information (CanSIS) data bank. This computerized system of data management permits automated manipulation and statistical evaluation of large volumes of data for soil characterization and interpretations. These data will shortly be available on request. In addition, the cartographic file of CanSIS provides a capability to produce derived maps of various kinds quickly and inexpensively. The types of derived maps that can be generated from the basic soil map include the sixteen interpretations that are provided in tabular form in this report as well as a number of single feature maps for such characteristics as drainage, texture of surface deposits, slope, stoniness, distribution of salinity, etc. A package of interpretive maps and single feature derivative maps can be made available on request to: The Canada-Manitoba Soil Survey, Dept. of Soil Science, Rm. 362, Ellis Bldg., University of Manitoba, Winnipeg R3T 2N2.

The Canada-Manitoba Soil Survey trusts that this report and accompanying map will be of value to all individuals and agencies involved with the use of land within the map area.

ACKNOWLEDGEMENTS

The soil study of the Rural Municipality of Rhineland was conducted as a joint project of the Manitoba Department of Agriculture and Agriculture Canada.

Grateful acknowledgement is made to the following persons:

J. Griffiths, R. DePape and M. Brown for compiling, drafting and digitizing the sketches and maps.

Gordon Mills for reviewing the manuscript.

C. Aglugub for providing computer processing, programming and report formatting.

D. Sandberg for typing, inputting and assisting in preparation of the report.

R. Mirza, J. Madden, E. St. Jacques and J. Yeung for laboratory analyses, carried out under the supervision of P. Haluschak.

The mapping and field work was carried out by G.P. Podolsky and I. G. Podolsky assisted by D. Prescott, D. Shearer, D. Timmerman, B. Stratuliak and D. Potter.

HOW TO USE THIS SOIL REPORT

This soils report contains considerable information about the soils, their origin and formation, their classification and their potential for various uses such as dryland agriculture, irrigation, engineering and recreation. The report is divided into four parts: Part I provides a general description of the area; Part 2 describes the methodology used in the study; Part 3 discusses the development, scientific classification and morphological characteristics of the soils in the study area, and Part 4 provides an interpretation of soil properties and associated landscape features as they affect soil capability or suitability for various uses.

The soil map of the study area is compiled on an uncontrolled air photo base which is included in a pocket of the report folder. The map shows the distribution of soil types and associated landscape features that are significant for potential use as field management units. It provides a linkage from landscapes within the study area to the information contained in the report.

To assist the user in retrieving soil information quickly, the following steps are suggested:

If project consists of many individual maps, proceed with STEP 1., if only single map in pocket, proceed with STEP 2 to 6.

STEP 1 Consult the index to map sheets if the report contains many maps. Locate the areas of interest and note the map-sheet number(s) which identify the township and range on each map.

STEP 2 Consult the soil map in pocket of report folder. Locate the area(s) of interest on the map and identify the pertinent map unit symbols. Arabic numerals placed as superscripts following map symbols indicate the approximate proportion of each soil type within the map unit.

STEP 3 Consult the extended legend accompanying the soil map for an alphabetical listing of soil symbols giving the soil name, classification, drainage and related information concerning landforms, nature and depth of materials, and dominant vegetation.

STEP 4 For interpretive information about the soils, consult the appropriate Table in Part 4. Criteria utilized as guidelines in making these interpretations are provided in the Appendix.

STEP 5 Further information concerning the morphological properties and extent of the soils is presented in Part 3 where the soils are described alphabetically according to soil name.

STEP 6 Additional site specific information not contained in this report is available on request from the Canada-Manitoba Soil Survey, Ellis Bldg., University of Manitoba.

Table 1. Summary of Soil Survey Coverage for Manitoba

JANUARY, 1991

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Descrip.	Survey[3] Intensity	Map Scale	Map[4] Base	Land Eval.[5] & Interp.
Detailed Studies and Surveys								
D1	Pasquia (No. 11)	Pub. 1960	57 200	a,b,d	3	1:63,360	Color	A
D2	Glenlea Research Station	Int. 1963	541	a,b	1	1:7,920	Photo	A
D3	Morden Experimental Farm	Int. 1961	256	a,b	1	1:12,000	Photo	A
D4	Onanole	Pub. 1968	768	a,b	1	1:7,920	Photo	U
D5	York Factory Area	Int. 1969	768	a	3	1:63,360	B&W	
D6	McCreary Tile Drain Project	Int. 1971	64	a,b	1	1:5,000	B&W	A
D7	Brandon Experimental Farm	Int. 1985	768	a,b	1	1:7,920	Photo	A
D8	Portage Potato Farm	Int. 1972	480	a,b	1	1:4,800	Photo	A
D9	Portage la Prairie (No. 17)	Pub. 1972	113 200	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D10	Morden-Winkler (No. 18)	Pub. 1973	71 424	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D11	Deep Lake	Int. 1975	1 400	a,b	1	1:6,000	B&W	R
D12	Thompson Environmental Study	Int. 1976	32	a,b	1	1:1,000	B&W	
D13	Organic Soil Study of Alexander L.G.D.	Int. 1975	29 456	a,b	3	1:63,360	B&W	A
D14	Winnipeg Region	Pub. 1975	306 000	a,b,c	2	1:20,000	Photo	A,E,U,R
D15	Brandon Region	Pub. 1976	73 250	a,b,c	2	1:20,000	Photo	A,E,U,R
D16	Boissevain-Melita (No. 20)	Pub. 1978	262 912	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D17	Roseau River	Pub. 1977	45 200	a,b	3	1:20,000	B&W	A
D18	Orr Lake	Int. 1977	20	a,b	1	1:1,000	B&W	
D19	Pelican-Rock Lake	Pub. 1983	14 080	a,b	2	1:20,000	Photo	A,E,R,I
D20	West Portage-MacGregor	Pub. 1982	124 866	a,b	2	1:20,000	Photo	A,I,E,R
D21	Minnewasta	Pub. 1978	2 560	a,b	2	1:20,000	Photo	A,E,R,I
D22	Killarney	Pub. 1979	4 600	a,b	2	1:20,000	Photo	A,E,R,I
D23	Matlock-Gimli-Riverton	Pub. 1981	18 400	a,b	2	1:20,000	Photo	A,E,R,I
D24	Glenboro	Pub. 1979	5 960	a,b	2	1:20,000	Photo	A,E,R,I
D25	Sandy Lake	Pub. 1980	1 720	a,b	2	1:20,000	Photo	A,E,R,I
D26	Brokenhead	Pub. 1979	10 813	a,b	2	1:20,000	Photo	A,E,R,I,U
D27	Rockwood	Pub. 1980	12 928	a,b	2	1:20,000	Photo	A,E,R,I,U
D28	Oak Lake	Pub. 1979	1 293	a,b	2	1:20,000	Photo	A,I
D29	Bird River	Pub. 1980	2 560	a,b	2	1:20,000	Photo	A,E,R
D30	North Shore Lac du Bonnet	Pub. 1980	2 400	a,b	2	1:20,000	Photo	A,E,R
D31	Grindstone Point	Pub. 1979	8 223	a,b	2	1:20,000	Photo	A,E,R
D32	Paint Lake	Int. 1980	2 880	a,b	2	1:10,000	Photo	A,E,R
D33	Cranberry Portage	Int. 1980	80	a,b	1	1:5,000	Photo	A,E,R
D34	Dauphin	Pub. 1981	8 005	a,b	2	1:20,000	Photo	A,E,R,I
D35	South Riding Mtn.	Pub. 1991	23 488	a,b	2	1:20,000	Photo	A,E,R
D36	West Interlake	Pub. 1981	10 036	a,b	2	1:20,000	Photo	A,E,I,R
D37	Swan R. Townsite	Pub. 1987	7 680	a,b	2	1:20,000	Photo	A,E,R,I
D38	Hadashville-organic	Pub. 1981	6 475	a,b	3	1:40,000	Photo	A,E,I,R
D40	Falcon L-Brereton L	Pre.	39 311	a,b	2	1:20,000	Photo	A,E,R
D41	Quesnel Lake-North Shore Winnipeg River	Pre.	6 009	a,b	2	1:20,000	Photo	A,E,R
D42	Duck Mountain	Pub. 1982	3 036	a,b	2	1:20,000	Photo	A,E,R
D43	Spruce Woods	Pre.	26 300	e	3	1:40,000	Photo	A,E,R
D45	Pine Creek	Pub. 1983	1 942	a,b	2	1:20,000	Photo	A,E,R,I
D46	Arborg-Riverton	Pub. 1982	2 590	a,b	2	1:20,000	Photo	A,E,R,I
D47	Roblin	Pub. 1983	4 096	a,b	2	1:20,000	Photo	A,E,R,I
D48	Flin Flon	Pub. 1989	4 600	a,b	2	1:20,000	Photo	A,E,R
D49	St. Anne-La Broquerie, Part of L.D.G. Stuartburn	Pub. 1985	105 280	a,b	3	1:50,000	B&W	A,E,R,I
D50	City of Brandon	Pub. 1984	2 980	a,b	2	1:20,000	Photo	A,E,R,I
D51	Westbourne	Pub. 1985	51 456	a,b	2	1:20,000	Photo	A,E,R,I

Summary of Soil Survey Coverage for Manitoba (Cont'd)

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Descrip.	Survey[3] Intensity	Map Scale	Map[4] Base	Land Eval.[5] & Interp.
D52	Notre Dame, Rathwell, Treherne Townsites	Pub. 1984	6 144	a,b	2	1:20,000	Photo	A,E,R,I
D53	Altona, Emerson, Gretna, Ile des Chenes, Landmark, Letellier, Rosenort, St. Jean Townsites	Pub. 1984	14 080	a,b	2	1:20,000	Photo	A,E,R,I
D54	Russell, Binscarth-Townsites	Pub. 1984	3 791	a,b	2	1:20,000	Photo	A,E,R,I
D55	St. Rose Du Lac-Townsite	Pub. 1985	1 536	a,b	2	1:20,000	Photo	A,E,R,I
D56	Souris, Wawanesa, Virden, Townsites	Pub. 1986	6 400	a,b	2	1:20,000	Photo	A,E,R,I
D57	Fraserwood, Inwood, Komarno Townsites, Lake Man. Shoreline	Pub. 1987	1 856	a,b	2	1:20,000	Photo	A,E,R,I
D58	Hallboro, Minnedosa-Townsites	Pub. 1984	4 544	a,b	2	1:20,000	Photo	A,E,R,I
D59	Beaudry Park	Pub. 1986	640	a,b	2	1:20,000	Photo	A,E,R
D60	Rural Municipalities of Dufferin, Grey, Roland, Thompson and Stanley	Pub. 1988	325 000	a,b	2	1:20,000	Photo	A,E,R,I
D61	Meditation Lake	Pre.	3 072	a,b	2	1:20,000	Photo	A,E,R
D62	Wanipigow Lake	Pre.	8 960	a,b	2	1:20,000	Photo	A,E,R
D63	Shellmouth Resevoir-N	Pub. 1987	4 650	a,b	2	1:20,000	Photo	A,E,R,I
D64	Assiniboine River	Pub. 1987	4 095	a,b	2	1:20,000	Photo	A,E,R,I
D65	Villages of Hamiota,Elkhorn, Strathclair, Rapid City, Newdale, Birtle, Shoal Lake	Pub. 1989	6 204	a,b	2	1:20,000	Photo	A,E,R,I
D66	Benito-Durban	Pre.	18 432	a,b	2	1:50,000	Photo	A,E,R,I
D67	St. Eustache, Springstein, Perimeter Strip, Brunkild, La Salle R.	Pub. 1989	6 300	a,b	2	1:20,000	Photo	A,E,R,I
D68	Spruce Point Mine Area	Pub. 1987	450	a,b	2	1:10,000	Photo	E,R
D69	Snow Lake	Pub. 1990	3 800	a,b	2	1:20,000	Photo	A,E,R,I
D70	Lorne	Pub. 1987	93 240		3,2	1:50,000	B&W,Photo	A,E,R,I
D71	Whitemouth Peatland	Pub. 1987	10 359	a,b	3	1:50,000	Photo	A,E,R,I
D72	Woodlands R.M.	Pre.	9 728	a,b	3	1:50,000	Photo	A,E,R,I
D73	Elk Island-Victoria Beach	Pub. 1990	2 095	a,b	2	1:20,000	Photo	A,E,R,I
D74	South Norfolk R.M.	Pub. 1988	70 912	a,b	2	1:20,000	Photo	A,E,R,I
D75	Victoria R.M.	Pub. 1989	67 328	a,b	2	1:20,000	Photo	A,E,R,I
D76	Rhineland	Pub. 1991	93 241	a,b	2	1:20,000	Photo	A,E,R,I
D77	Pembina	Pre.	108 288	a,b	3	1:50,000	B&W	A,E,R,I
D78	Springfield*	Data	98 270	a,b	2	1:20,000	Photo	A,E,R,I
D79	Rockwood R.M.*	Pre.	116 550	a,c	4	1:125,000	B&W	A,E,R,I
D80	North Norfolk R.M.	Pub. 1991	115 503	a,b	2	1:20,000	Photo	A,E,R,I
D81	Plum Lake	Pub. 1989	15 500	a,b	2	1:20,000	Photo	A,E,R,I
D82	Hanover R.M.	Pre.	8 192	a,b	2	1:20,000		A,E,R,I
		Data	65 536	a,b	3	1:50,000	B&W	A,E,R,I
D83	Louise R.M.	Data	92 416	a,b	3	1:50,000	B&W	A,E,R,I
D84	Argyle R.M.	Data	83 712	a,b	3	1:50,000	B&W	A,E,R,I

* Upgrade of Data Base

Summary of Soil Survey Coverage for Manitoba (Cont'd)

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Descrip.	Survey[3] Intensity	Map Scale	Map[4] Base	Land Eval.[5] & Interp.
Reconnaissance Surveys								
R1	South Western (No. 3)	Pub. 1940	709 600	d	3	1:125,000	B&W	A
R2	South Central (No. 4)	Pub. 1943	967 600	d	3	1:125,000	B&W	A
R3	Winnipeg and Morris (No. 5)	Pub. 1953	1 419 200	d	3	1:125,000	Color	A
R4	Rossburn and Virden (No. 6)	Pub. 1956	1 372 400	d	3	1:125,000	Color	A
R5	Carberry (No. 7)	Pub. 1957	967 600	d	3	1:125,000	Color	A
R6	West-Lake (No. 8)	Pub. 1958	592 800	d	3	1:125,000	Color	A
R7	Grandview (No. 9)	Pub. 1957	689 200	d	3	1:125,000	Color	A
R8	Nelson River Basin (No. 10)	Pub. 1973	224 000	b	3	1:100,000	Color	A
R9	Fisher and Teulon (No. 12)	Pub. 1961	949 200	a,c	3	1:100,000	Color	A
R10	Swan River (No. 13)	Pub. 1962	316 000	a,c	3	1:125,000	Color	A
R11	South Eastern (No. 14)	Pub. 1964	749 200	a,c	3	1:125,000	Color	A,F
R12	Lac du Bonnet (No. 15)	Pub. 1967	764 800	a,c	3	1:125,000	Color	A,F,R
R13	Grahamdale (No. 16)	Pub. 1971	764 800	a,b	3	1:125,000	Color	A,F,U,R,E
R14	Red Rose-Washow Bay (No.19)	Pub. 1975	704 400	a,b	3	1:125,000	Color	A,F
R15	Boissevain-Melita (No. 20)	Pub. 1978	299 520	a,b	2	1:40,000	Photo	A,I,E
R16	Ste. Rose (No. 21)	Pub. 1981	676 705	a,b	3	1:125,000	Color	A,I,R,E,F
R17	Waterhen (No. 23)	Pub. 1985	949 600	a,b	4	1:125,000	B&W	A,I,R,E,F
R18	Swan Lake	Data	599 200	a,b	3,4	1:125,000	B&W	A
R19	The Pas (No. 22)	Pub. 1982	791 700	a,b	4	1:125,000	Color	A,I,E,R,F
R20	Grand Rapids	Pre.	657 031	a,b	4	1:125,000	B&W	A
R21	Cormorant	Int. 1975	920 000	a,b	4	1:125,000	B&W	A
R22	Wekusko	Pre.	1 400 000	a,b	4	1:125,000	B&W	A
R23	Pointe du Bois	Pre.	740 000	a,b				
R25	Red Deer Lake	Pub. 1966	34 860	a,b	2	1:31,680	Photo	A
R26	Cross Lake and Norway House	Pre.	615 200	a,b	4	1:125,000	B&W	A
R28	Pasquia Lake	Pub. 1984	2 330	a,b	3	1:50,000	B&W	A,E
R29	Duck Mountain For. Reser.	Pre.	363 264	a,b,c	4	1:125,000	B&W	A,F,E,R,I
Biophysical and Exploratory Surveys								
B1	Lake Winnipeg, Churchill & Nelson Rivers	Pub. 1973	3 600 000	e	4	1:250,000 1:50,000	B&W	
B2	Churchill Transportation Corridor	Data 1974	179 000	f	4	1:125,000	B&W	
B3	54C Hayes River	Int. 1976	1 370 300	f	4	1:125,000	B&W	
B4	54D Kettle Rapids	Int. 1976	1 370 300	f	4	1:125,000	B&W	
B5	52M Carrol Lake	Int. 1977	634 000	f	4	1:125,000	B&W	
B5	62P Hecla	Int. 1977	466 200	f	4	1:125,000	B&W	
B6	53D Deer Lake	Int. 1978	629 700	f	4	1:125,000	B&W	
B6	63A Berens River	Int. 1978	848 500	f	4	1:125,000	B&W	
B7	53M Knee Lake	Int. 1978	1 405 900	f	4	1:125,000	B&W	
B8	53L Oxford House	Int. 1978	1 441 100	f	4	1:125,000	B&W	
B8	63H Norway House	Data	540 800	f	4	1:125,000	B&W	
B9	SE 1/4 64A Split Lake	Int. 1979	342 400	f	4	1:125,000	B&W	
B9	63P Sipiwesk	Int. 1979	1 405 900	f	4	1:125,000	B&W	
B10	53E Island Lake	Pre.	1 286 900	f	4	1:125,000	B&W	
B11	63H Norway House	Data				1:125,000	MSS	
E1	Surface Deposits & Soils of Northern Manitoba	Int. 1963		g	5	1:1,267,000	B&W	
E2	Exploratory Terrain Study of Northern Manitoba and Southern Keewatin, N.W.T.	Int. 1974		g	5	1:1,000,000	B&W	

Summary of Soil Survey Coverage for Manitoba (Cont'd)

1. Report Status
   - Pub.-Published Report and Map
   - Int.-Interim Report and Map Available
   - Pre.-Preliminary Map and Legend Available
   - Data-Field Data Available Only

2. Map Unit Descriptions Code
   - a-single series and phases
   - b-series complexes defined as to proportion
   - c-series complexes undefined as to proportion
   - d-associations
   - e-biophysical units (materials and physiography)
   - f-biophysical units (associations & complexes of associations)
   - g-regional and local physiographic units

3. Survey Intensity Levels

Code	Name	Scale	Minimum Size Delineation(ha)	Inspection Density (Approx. range)
1	Very detailed	>1:12,000	<1.5	>1 per 3 ha
2	Detailed	1:12,000 to 1:40,000	1.5-16	1 per 3 to 50 ha
3	Semi-detailed	1:40,000 to 1:125,000	16 to 256	1 per 10 to 1 000 ha
4	Reconnaissance	1:125,000 to 1:250,000	256 to 625	1 per 100 to 110 000 ha
5	Exploratory	1:250,000 to 1:1,000,000	625 to 110 000	1 per 300 to 500 000 ha

4. Published Map Base Code
   - Photo-Photomosaic
   - B&W -Black and white line
   - Color-Colored line

5. Land Evaluation and Interpretations Code
   - A-Agriculture Capability
   - E-Engineering
   - F-Forestry
   - I-Irrigation Suitability
   - U-Urban Planning and Community Development
   - R-Recreation

TOTAL HECTARAGE COVERED	1990	To Date
Initial Reconnaissance	-	19,271,010
Initial Detailed survey	-	18,793
Detailed Resurvey	148,480	3,658,598
Biophysical Survey	-	12,521,000

Published Reports and Maps,
available at a cost of $4.00 per copy
(except Detailed Survey of Winnipeg
Region(D14), Brandon Region(D15) and
and Boissevain-Melita(No. 20) at a
cost of $6.00 each) from:

Queen's Printer,
Statutory Publications Branch,
Manitoba Archives Bldg.,
200 Vaughan St.,
Winnipeg, Manitoba R3C 1T5
Phone:945-3103

Information regarding,
Biophysical Land Classification Maps and Reports
is available by contacting office of the:

Canada-Manitoba Soil Survey
Department of Soil Science, Ellis Bldg.,
University of Manitoba
Winnipeg, Manitoba, R3T 2N2
Phone: (204) 474-6119
Fax: (204) 275-5817

Preliminary Maps and other field data
of Survey Projects in progress available
from:

Canada-Manitoba Soil Survey Office
Rm. 362 Ellis Bldg., University of Manitoba
Winnipeg, Man. R3T 2N2
Phone: 474-6115 or 474-6118

TABLE OF CONTENTS

PREFACE i

ACKNOWLEDGEMENTS ii

HOW TO USE THIS SOIL REPORT iii

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA iv

PART 1 1

1 GENERAL DESCRIPTION OF THE STUDY AREA 1
1.1 LOCATION AND EXTENT 1
1.2 LAND USE 1
1.3 RELIEF AND DRAINAGE 1
1.4 PHYSIOGRAPHY 4
1.5 SURFACE DEPOSITS AND GENERALIZED SOIL GROUPS 4
1.6 GENERALIZED SOIL GROUPINGS 4
1.7 GEOLOGY 7
1.8 GROUNDWATER 13
1.9 CLIMATE 13
1.10 VEGETATION 13

PART 2 16

2 METHODOLOGY 16
2.1 MAPPING 16
2.2 MAP UNITS 16
2.3 SIMPLE AND COMPOUND MAP UNITS 16
2.4 PHASES 17
2.5 SAMPLING 18

PART 3 19

3 DEVELOPMENT, CLASSIFICATION AND DESCRIPTION OF SOILS 19
3.1 SOIL DEVELOPMENT 19
3.2 SOIL SERIES DESCRIPTIONS 20
Black Lake Series (BCK) 26
Birkenhead Series (BKA) 26
Blumengart Series (BMG) 26
Blumenfeld Series (BNF) 26
Blumenort Series (BUM) 27
Chortitz Series (CTZ) 27
Dencross Series (DCS) 27
Dufresne Series (DFS) 28
Dugas Series (DGS) 28
Deadhorse Series (DHO) 28
Denham Series (DNH) 29
Edenburg Series (EBG) 29
Edkins Series (EDK) 29
Eigenhof Series (EGF) 30

Gnadenthal Series (GDH) 30
Glenmoor (GOO) 30
Gretna Series (GRA) 31
Graysville Series (GYV) 31
Hoddinott Series (HDN) 31
Hochfeld Series (HHF) 32
Hibsin Series (HIN) 32
Horndean Series (HND) 32
Jordan Series (JOD) 33
Jasset Series (JST) 33
Kronstal Series (KOT) 33
Loewen Series (LEW) 34
Lakeland Series (LKD) 34
Morris Series (MRS) 34
Myrtle Series (MYT) 35
Neuenberg Series (NBG) 35
Neuhorst Series (NUH) 35
Newton Siding Series (NWN) 36
Osborne Series (OBO) 36
Osterwick Series (OWK) 36
Plum Coulee Series (PME) 36
Rosebank Series (RBK) 37
Reinfeld Series (RFD) 37
Rignold Series (RGD) 37
Red River Series (RIV) 38
Reinland Series (RLD) 38
Rosengart Series (RSG) 38
Rathwell Series (RWL) 39
Scanterbury Series (SCY) 39
Seine River Series (SRE) 39
Winkler Series (WIK) 40

PART 4 41

4 USE AND MANAGEMENT INTERPRETATIONS OF SOILS 41
4.1 INTRODUCTION 41
4.2 SOIL CAPABILITY FOR AGRICULTURE 41
Dryland Agriculture 41
Soil Capability subclasses 41
4.3 CAPABILITY AND MANAGEMENT 41
Definitions of the Agricultural Capability Classes 43
Irrigation Suitability 51
4.4 SOIL SUITABILITY FOR SELECTED ENGINEERING USES 51
Definition of Soil Suitability Classes 51
Soil Suitability Subclasses 52
Guides for Assessing Soil Suitability 52
4.5 SOIL SUITABILITY FOR SELECTED RECREATION USES 53

BIBLIOGRAPHY 63

APPENDIX A 64
CORRELATION OF THE SOILS IN THE RURAL MUNICIPALITY OF RHINELAND DETAILED RESURVEY WITH SOILS IN THE RECONNAISSANCE MORRIS MAP SHEET AREA, REPORT NO. 5, 1953 64

APPENDIX B 73

GUIDES FOR EVALUATING SOIL SUITABILITY FOR SELECTED USES 73

APPENDIX C 89
GLOSSARY 89

APPENDIX D 100
SOIL HORIZON DESIGNATIONS 100
ORGANIC HORIZONS 100
MASTER MINERAL HORIZONS 100
LOWER-CASE SUFFIXES 101

APPENDIX E 105
DESCRIPTION OF LANDFORMS 105
GENETIC MATERIALS 105
Unconsolidated mineral component 105
Qualifying Descriptors 105
Organic component 106
GENETIC MATERIAL MODIFIERS 106
Particle size classes for unconsolidated mineral materials 106
Fiber classes for organic materials 107
SURFACE EXPRESSION 107
Consolidated and Unconsolidated mineral surface classes 107
Organic surface classes 108

APPENDIX F 109
DAILY SITE DESCRIPTIONS AND DETAILED SOIL DESCRIPTIONS DATA 109
DRILL DATA AND ANALYSIS 111
SOIL WATER HOLDING CAPACITIES 114

APPENDIX G 117
MAP UNIT SYMBOLOGY 117
LEGEND 118
MAP SHEET INDEX 120

LIST OF TABLES

Table 1.	Summary of Soil Survey Coverage for Manitoba	iv
Table 2.	Climatic Data from Stations[6] at Altona and Gretna	14
Table 3.	Key to the Soil Series of the R.M of Rhineland in the Grassland Transition Ecoclimatic Region (Subregions 1 and 4). Arranged in Relation to Soil Moisture Class, Subgroup and Parent Material	21
Table 4.	Parent Materials and Related Soils of the Study Area	22
Table 5.	Agricultural Capability Subclass Limitations	44
Table 6.	Agricultural Interpretations of Soils in the Study Area	45
Table 7.	Areal Extent in Hectares and Percent Coverage by Soil Series and Phases in the R.M. of Rhineland.	48
Table 8	Codes utilized to identify limitations in evaluating soil suitability for selected Engineering and Recreational Uses (Table 10 and 11)	53
Table 9.	Engineering Description of the Soils and Their Estimated Properties Significant to Engineering	54
Table 10.	Suitability Ratings and Limitations for Soils in the Study Area for Selected Engineering Uses	57
Table 11.	Suitability Ratings and Limitations of Soils in the Study Area for Various Recreational Uses	60
Table 12.	Correlation of Soil Series in the R.M. of Rhineland with Soil Associations and Associates of the Morris Map Sheet Area, Report No. 5, 1953	65
Table 13.	Correlation of Soil Names and Phase Symbols in the Morden-Winkler Report No. 18 with the Soil Symbols and Phase Notations in this Report (D76)	71
Table 14	Land Classification Standards for Irrigation Suitability	74
Table 15	Guide for assessing soil suitability as source of topsoil	75
Table 16	Guide for assessing soil suitability as source of sand and gravel	76
Table 17	Guide for assessing soil suitability as source of roadfill	77
Table 18	Guide for assessing soil suitability for permanent buildings	78
Table 19	Guide for assessing soil suitability for local roads and streets	79
Table 20	Guide for assessing soil suitability for trench-type sanitary landfills	80
Table 21	Guide for assessing soil suitability for area-type sanitary landfills	81
Table 22	Guide for assessing soil suitability as cover material for area-type sanitary landfills	82
Table 23	Guide for assessing soil suitability for reservoirs and sewage lagoons	83
Table 24	Guide for assessing soil suitability for septic tank absorption fields	84
Table 25	Guide for assessing soil suitability for playgrounds	85
Table 26	Guide for assessing soil suitability for picnic areas	86
Table 27	Guide for assessing soil suitability for camp area	87
Table 28	Guide for assessing soil suitability for paths and trails	88
Table 29.	Drill Data and Analysis	111
Table 30.	Soil Water Holding Capacities	115

LIST OF FIGURES

Figure 1. Location of Study Area 2
Figure 2. Relief and Drainage Map 3
Figure 3. Physiographic Regions of the Study Area 5
Figure 4. Surficial Deposits and Generalized Soil Groupings - Legend 6
Figure 5. Location of Stratigraphic Cross-Sections in the R.M. of Rhineland 8
Figure 6. East-West Cross-Section (A-A') Showing the Surficial Stratigraphy in the Northern part of the R.M. of Rhineland 9
Figure 7. East-West Cross-Section (B-B') Showing the Surficial Stratigraphy in the Central part of the R.M of Rhineland 10
Figure 8. East-West Cross-Section (C-C') Showing the Surficial Stratigraphy in the Southern part of the R.M. of Rhineland 11
Figure 9. Geology of the Study Area 12
Figure 10. Ecoclimatic Regions of the Study 15
Figure 11. Family particle-size Classes 99
Figure 12. Soil Textural Classes 99
Figure 13. Drill and Sample Sites 110

PART 1

1 GENERAL DESCRIPTION OF THE STUDY AREA

1.1 LOCATION AND EXTENT

The Rural Municipality of Rhineland is located immediately north of the International Boundary in the south central part of the Red River Valley. It is positioned in the extreme southwest corner of the Morris Map Sheet area. The Red River lies to the east of the R.M., the villages of Sewell and Kronsgart mark the northern limit, while Emerado Beach (900 ft. contour) runs just to the west. The municipality covers a total of 10 townships (93,241 ha) as shown in Figure 1. Plum Coulee, Altona and Gretna are the larger centres in the study along with a network of smaller villages established during the colonization by the Mennonite pioneers.

This project is a detailed resurvey at a scale of 1:20,000 of an area formerly covered in the reconnaissance survey of the Morris Map Sheet Area (Report No. 5, 1953) at a scale of 1:126,720. The current report incorporates the three western most townships, i.e., Twps 1,2,3 Rge. 3W, of the municipality from the "Soils of the Morden-Winkler Area", Report No. 18, as well as coverage around Altona and Gretna from Report No. D-53, "Soils of the Towns of Altona, Emerson, Gretna, Ile des Chenes, Landmark, Letellier, Rosenort and St. Jean Baptiste". A summary of soil survey coverage for Manitoba is outlined in Table 1.

1.2 LAND USE

The land use and economy of the area is based on intensive and diversified agricultural production. The prime land is conducive to the growing of a variety of crops including all cereal grains, sunflower, canola, flax, corn, sugar beets, potatoes plus other specialty crops such as canary seed, peas, beans and lentils. Potato production favours the lighter textured soils in the southwest portion of the municipality. In addition there are several fairly large hog and poultry operations in the area along with limited livestock and dairy production.

The R.M. of Rhineland constitutes a major portion of what was called the "West Reserve" which was settled by the first Mennonites in Manitoba. In the colonization of the reserve, the Mennonites established a pattern of small, nucleated villages and a form of cooperative, open field, strip farming which they brought with them from Russia. Today although numerous small villages still exist, there are only remnants of the strip farming system which proved to be inefficient. Fragmented narrow fields caused excessive, wasteful travelling and limited expansion.

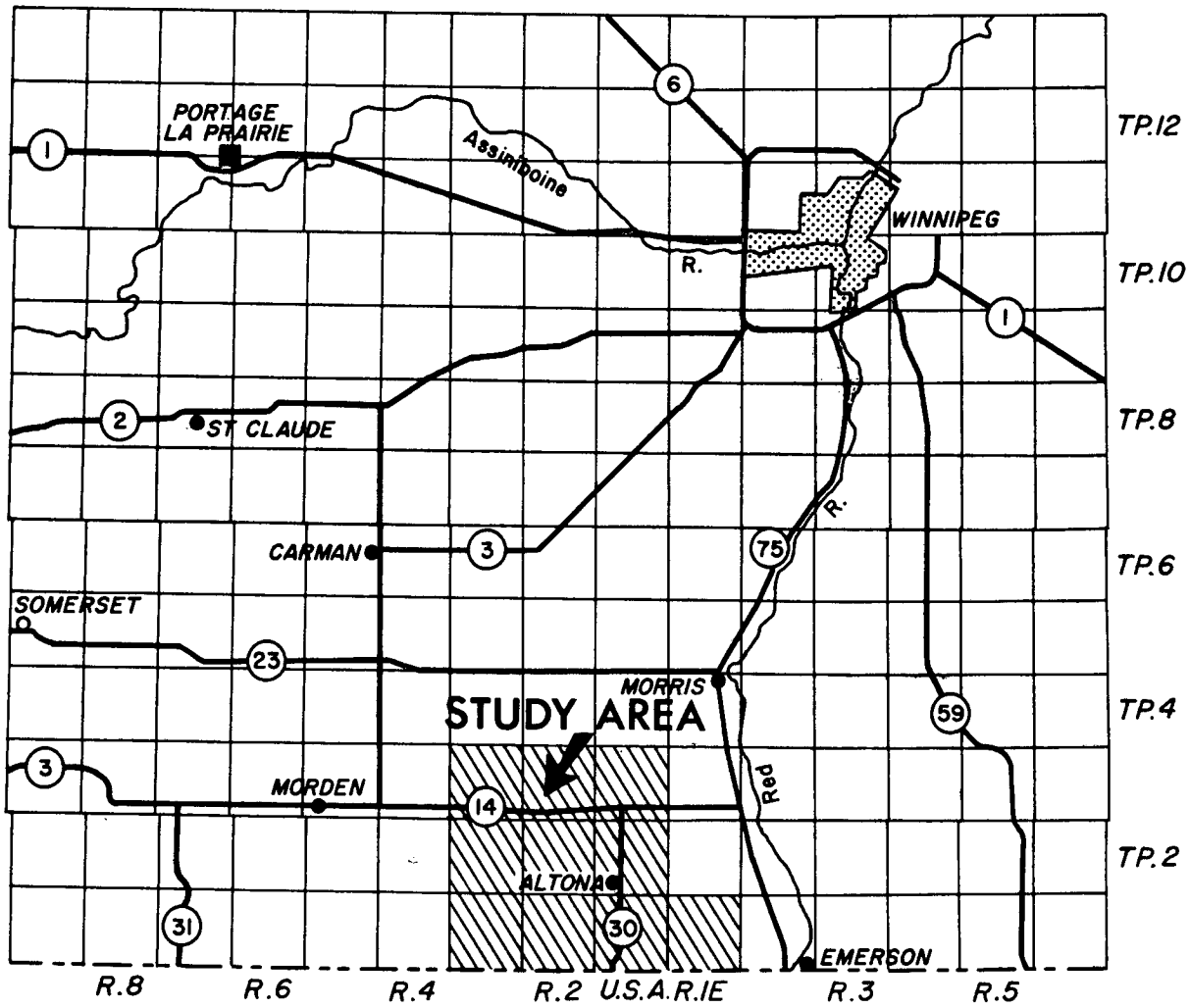
The larger towns in the area, particularly Altona, are busy and progressive commercial and industrial centres. Gretna also serves as a custom port on the Canada-United States border. The towns supply most of the essential services including shopping centres, schools, agricultural supplies, banks, campgrounds, hospitals, service stations and recreational facilities. Local industrial development is remarkably varied and includes CSP Foods (Corporated Seed Processors Ltd.) and D.W. Friesen and Sons Ltd., a local printing firm in Altona. The Interprovincial Pipeline pumping station at Gretna handles a variety of oils and gases en route to Ontario and Quebec from Alberta fields.

1.3 RELIEF AND DRAINAGE

The principal relief and drainage features of the R.M. of Rhineland are shown in Figure 2. The elevation ranges from approximately 785 ft. (239 m) at the eastern edge of the R.M. to a height of 915 ft. (279 m) in the southwest corner of the study. From the southwest corner of Township 1, Range 3W, which coincides with the Emerado Beach, the land slopes gently eastward to the Principal Meridian at a rate of about 5 feet per mile (.95 m/km). From the Meridian eastward to the Red River the fall is around 2 ft. per mile (.4 m/km). The topography is generally level to very gently sloping with Tp. 3, R1W in the northeast corner being flat to somewhat depressional. Throughout a large portion of the municipality micro-relief is evident in the form of low and more or less continuous ridges that impart a very subdued slightly undulating appearance to much of the area. These ridges trend in a northwesterly and southeasterly direction. The creeks and streams provide the only natural breaks in relief over much of the study area.

The general drainage pattern or direction of flow in the R.M. of Rhineland is from west to east-

Figure 1. Location of Study Area



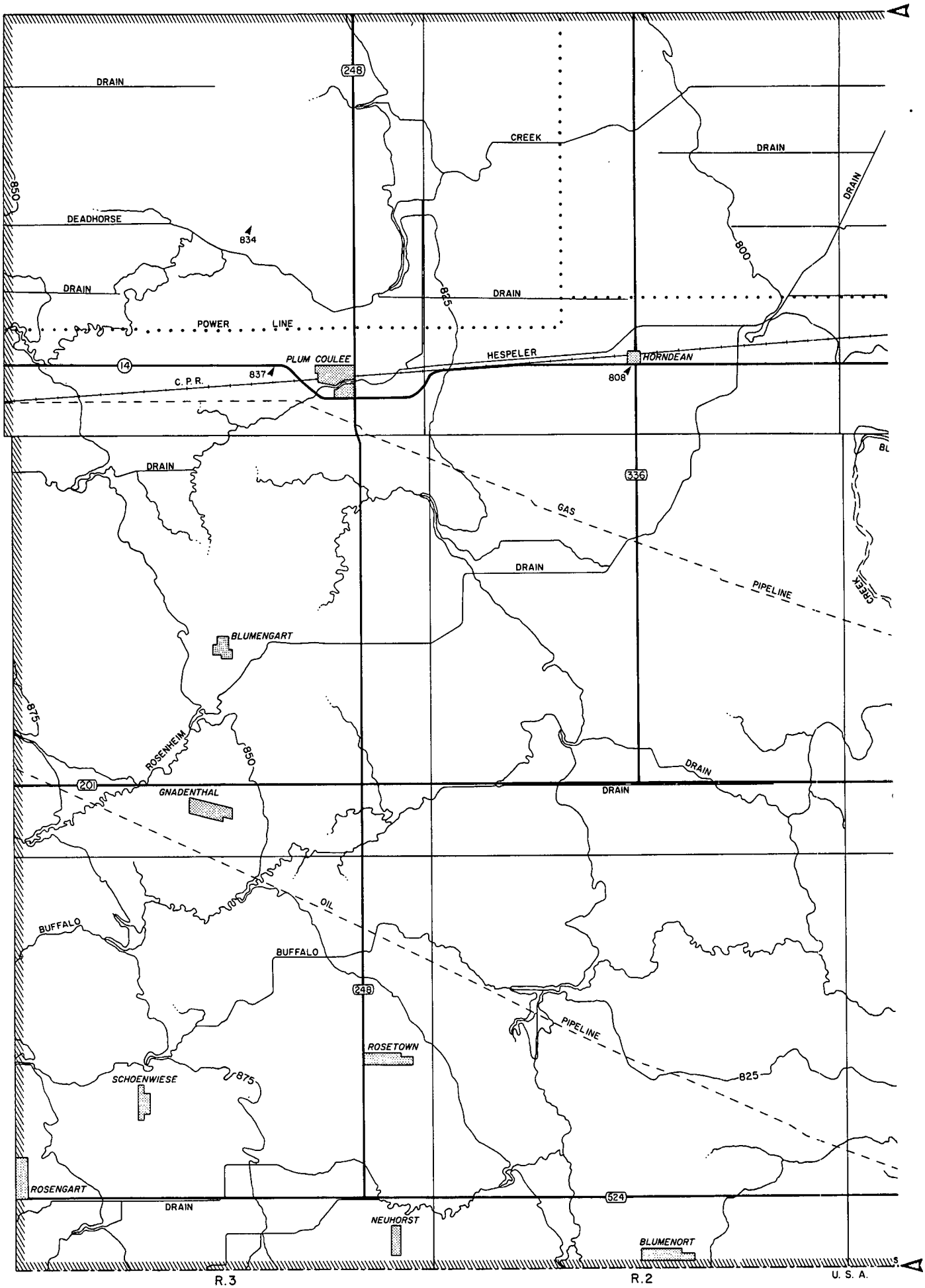
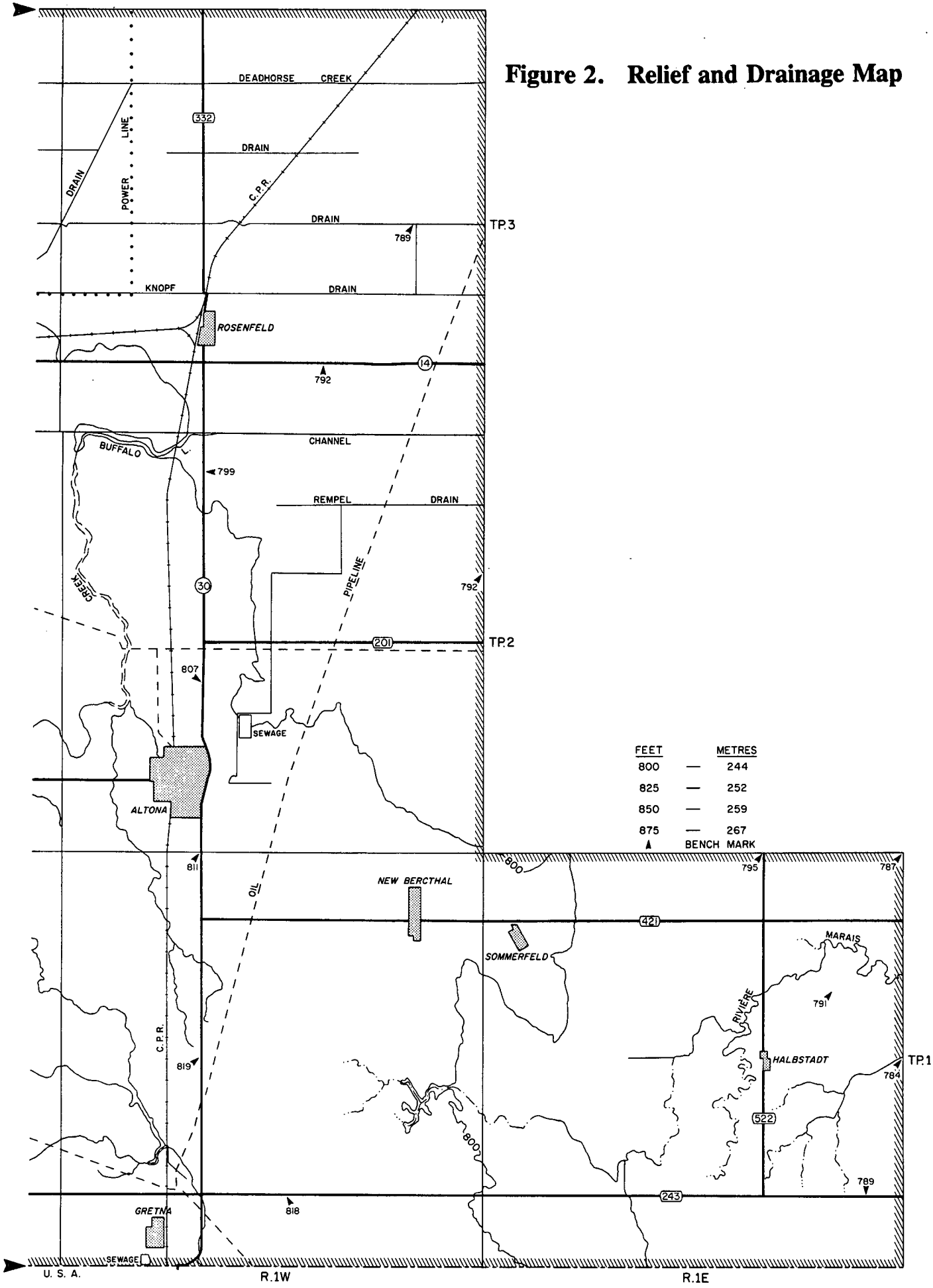

DRAIN
248
CREEK
DRAIN
DRAIN
850
DEADHORSE
834
800
DRAIN
825
DRAIN
POWER LINE
HESPELER
14
PLUM COULEE
HORNDEAN
837
808
C. P. R.
DRAIN
336
GAS
DRAIN
PIPELINE
BLUMENGART
875
ROSENHEIM
850
DRAIN
201
DRAIN
GNADENTHAL
OIL
BUFFALO
BUFFALO
248
PIPELINE
ROSETOWN
SCHOENWIESE
875
825
ROSENGART
DRAIN
524
NEUHORST
BLUMENORT
R.3
R.2
U. S. A.

Figure 2. Relief and Drainage Map



northeast. All surface waters from the R.M. are eventually carried away by the Red River. The drainage in the north and northwestern part of the R.M. is facilitated by the Deadhorse Creek and Hespeler drain along with their respective drains and ditches. The central and southwestern sections are drained by the Buffalo-Plum River channel and its tributary creeks. The only natural body of water in the R.M. is the so-called Buffalo Lake near Altona, which is a wider portion in the upper section of the Plum River channel that extends about nine miles. Drainage in the southeast corner of the study is provided by the Marais River.

Due to the relatively smooth topography of the area the streams lack the well-developed courses necessary to provide adequate drainage of the lands through which they pass. As a result, the area depends to a large extent for its drainage on the man-made ditches and channels which supplement and discharge into the natural streams. The installation of a network of man-made drains has greatly improved the drainage and agricultural production throughout the municipality, particularly the eastern and northern townships.

1.4 PHYSIOGRAPHY

The entire municipality is in the Red River Plain section of the Manitoba Plain division. Further delineation places the study in the Red River Valley subsection (Figure 3). The landscape is described as a level to very gently sloping lacustrine plain characterized by deep lacustrine, deltaic and fluvial deposits.

1.5 SURFACE DEPOSITS AND GENERALIZED SOIL GROUPS

The depth of surficial deposits over bedrock throughout the R.M. of Rhineland generally ranges from 50 to 60 metres[1]. The stratigraphy consists of surficial lacustrine and deltaic materials to a depth of 27 to 42 metres. These deposits are in turn underlain by glacial till which ranges in thickness from approximately 18 to 26 m and rests on bedrock. A gravelly or cobbly contact zone frequently occurs at the lacustrine (clay) and till contact. The glacial till consists of a high proportion of fragments derived from carbonate rock, in a clay-silt matrix.

A generalized surface deposits map (to a depth of approximately 1.5m) is shown in Figure 4. This map is derived from the detailed soil maps and provides a quick overview of general surficial material distribution for the R.M. of Rhineland. The map is intended for application in broad scale regional development planning. In addition, three cross-sections shown in Figures 5 to 8 have been included to illustrate vertical and horizontal variability as related to the soils of the area. The cross sections were compiled using soil survey deep drill data.

A significant deviation from the average thickness of surface deposits in the study occurs on the western side of the municipality. Along the west-central length of range 3W there exists a major bedrock valley. The drift thickness (clay and till) in this buried valley reaches a maximum of about 120 metres.

1.6 GENERALIZED SOIL GROUPINGS

The surficial deposits map shown on Figure 4 serves as a basis for showing the distribution of generalized soil groups in the R. M. of Rhineland.

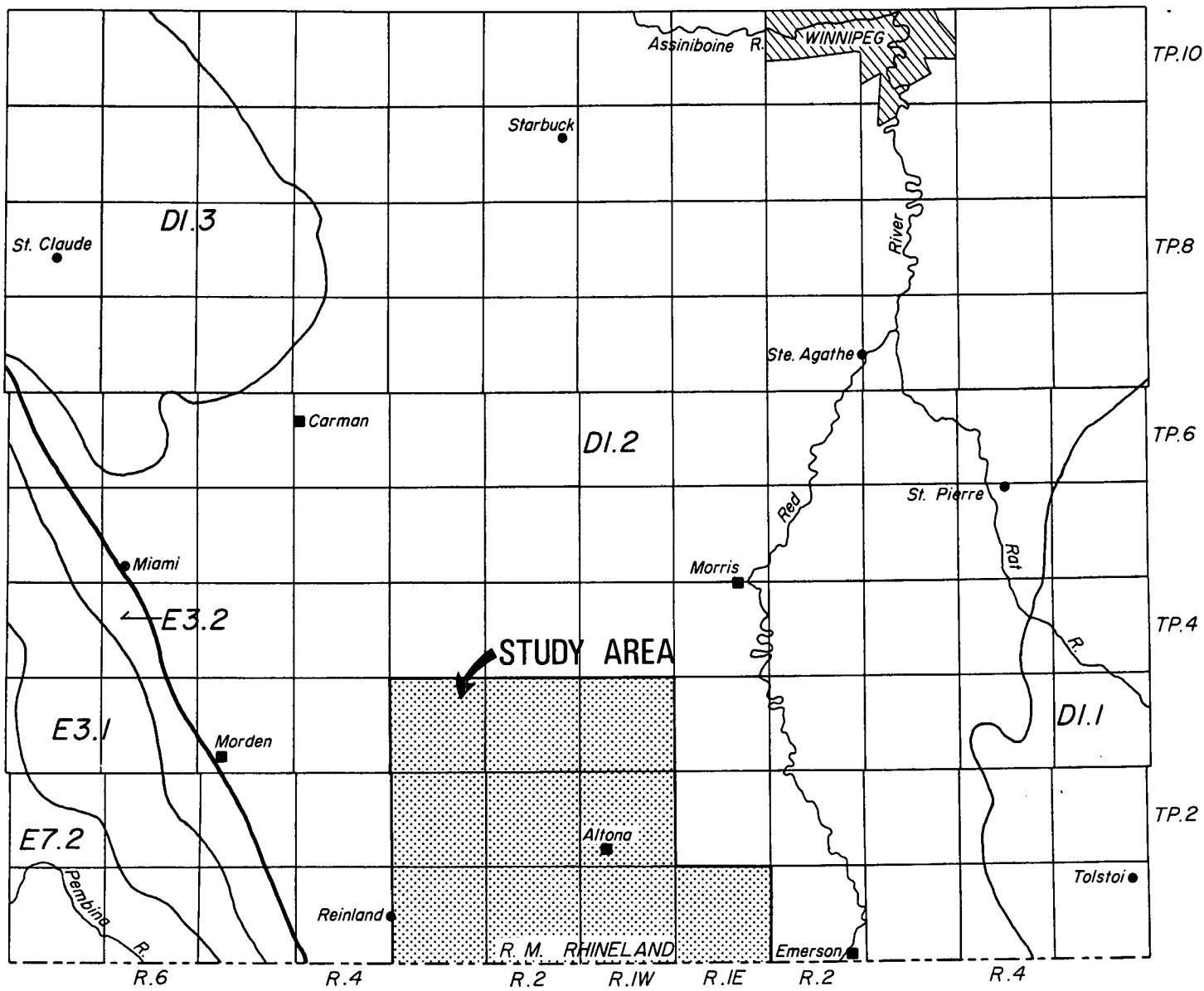
Generalized soil groups are used to describe areas of similar major diagnostic soil characteristics such as drainage, parent material and taxonomy at the Great Group level. The soil group name assigned to each map delineation is generalized from the dominant soils identified in the area on the detailed soil maps. Soil phases, subdominant components of compound map units and small soil areas are not recognized on the generalized soils map.

The generalized soil map provides an overview of general soil distribution for the Rural Municipality of Rhineland on one map sheet. This map is useful for broad-scale planning such as regional agricultural planning, regional engineering and recreational planning or for municipal development plans.

Black Chernozems and Humic Gleysol soils developed on lacustrine and deltaic deposits are dominant throughout the municipality. Local areas of immature Regosol soils occur in association with minor floodplain deposits.

Soil development and drainage in the study area combine with texture and stratigraphy to provide a linkage between surface deposits and soil groupings at this generalized scale. Dominant soil drainage is imperfect (Gleyed Rego Black, Gleyed Black and Gleyed Cumulic Regosols) in association with extensive areas of poorly drained Rego Humic Gleysols in which the natural drainage has been improved by a network of ditches and drains. Accumulation of soluble salts below a depth of about 50 cm are commonly observed throughout the study

Figure 3. Physiographic Regions of the Study Area



DIVISION	SECTION	SUBSECTION
D. Manitoba Plain	D1 Red River Plain	.1 Southeastern Plain
		.2 Red River Valley
		.3 Lower Assiniboine Delta
E. Saskatchewan Plain	E3 Pembina Hills Upland	.1 Pembina Hills
		.2 Pembina Escarpment
	E7 Pembina River Plain	.2 Manitou Plain

Figure 4. Surficial Deposits

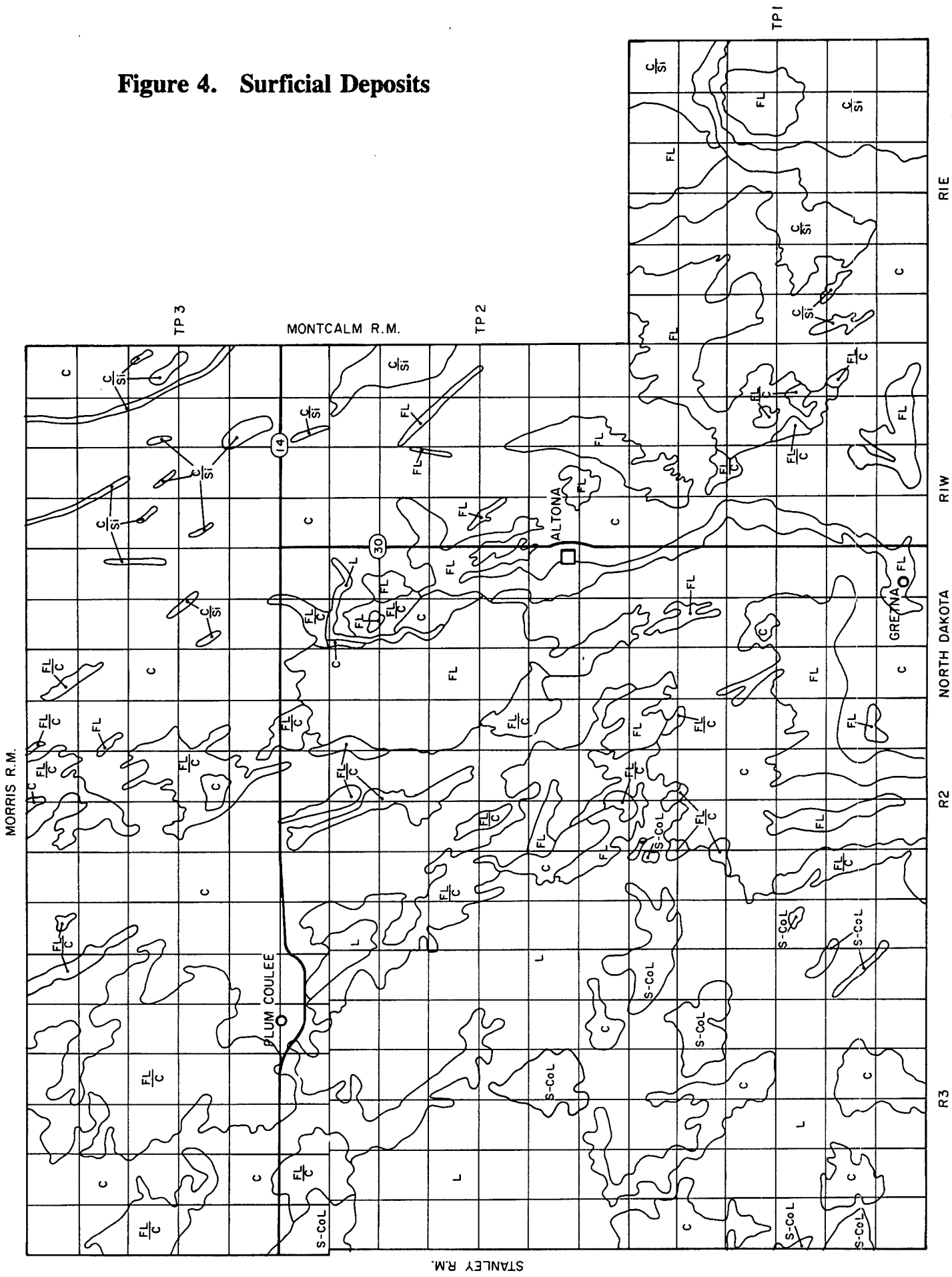


Figure 4. Surficial Deposits and Generalized Soil Groupings - Legend

Map Symbol	Particle Size	Soil Materials	Generalized Soil Group	Associated Soils*
C	Clayey-Clayey stratified	Clay, Silty Clay Loam, Silty Clay	Deadhorse-Dugas-Osborne (DHO,DGS,OBO)	Winkler(WIK), Plum Coulee(PME), Gretna(GRA), Jordan(JOD), Horndean(HND), Myrtle(MYT), Scanterbury(SCY), Red River(RIV), Morris(MRS), Blumengart(BMG), Blumenort(BUM), Black Lake(BCK), Dufresne(DFS), Seine River(SRE)
C/Si	Clayey/Silty	Clay/Silt, Silt Loam	Dencross(DCS)	Hoddinott(HDN), Glenmoor(GOO)
FL	Fine Loamy	Clay Loam-Sandy Clay Loam	Neuhorst-Newton Siding-Lakeland (NUH,NWN,LKD)	Eigenhof(EGF), Rathwell(RWL), Edenburg(EBG)
FL/C	Fine Loamy/ Clayey	Clay Loam/Clay	Graysville-Rignold (GYV,RGD)	Denham(DNH), Edkins(EDK)
L	Loamy	Very Fine Sandy Loam, Loam, Clay loam	Neuenberg-Gnadenthal-Chortitz (NBG,GDH,CTZ)	Rosengart(RSG), Jasset(JST), Reinfeld(RFD), Blumenfeld(BNF), Loewen(LEW)
S-Co.L	Sandy-Coarse Loamy	Sand-Sandy Loam	Reinland-Rosebank-Birkenhead(RLD,RBK,BKA)	Hochfeld(HHF), Kronstal(KOT), Hibsin(HIN)

* For additional information on soil drainage, subgroup and parent material, refer to Tables 3 and 4.

area on the imperfect to poorly drained soils. The composition of the salts is mainly calcium and magnesium sulfates with sodium sulfates being more common on the heavy textured soils in the Gretna area.

Extensive areas of clayey soils throughout the northern and central portion of the municipality are characterized by a somewhat stratified subsoil with layers of SiC to SiCL and thin bands of fine sand. The soils of the **Deadhorse-Dugas-Osborne Group** (DHO,DGS,OBO) also have occasional buried dark coloured layers high in organic matter. Local areas, e.g. near Gretna, exhibit solonetzic properties which cause tough compact soil structure and result in high tillage power requirements and difficulty in adequate seedbed preparation. The northeast township of the municipality is characterized by an extensive area of uniform, deep, somewhat poorly drained clayey soils of the Deadhorse-Dugas-Osborne Group (DHO, DGS,OBO). Osborne soils are dominant in this area which is subject to ponding and water logging following spring snowmelt or heavy summer rainfall. Delayed seeding in spring or crop damage during the growing season, if the soils are water logged for more than 3 or 4 days, results in reduced yield in some years.

In the southwestern part of the municipality the soils are largely loamy (VFSL to VFSCL) textured, **Neuenberg-Gnadenthal-Chortitz Group**, with a clay substrate at 1.8 to 3 m. The underlying clay retards internal drainage and tends to perch the water table in most years. These soils are easily maintained in good tilth and are moderately high to high in productivity for a wide range of grain and special crops. Very minor areas of loamy Chortitz soils comprised of variably stratified very fine sandy loam to clay loam recent alluvium are placed in this group. These imperfectly to poorly drained soils occur in areas adjacent to the streams and rivers in the municipality and are subject to flooding.

Locally extensive areas of deeper, fine loamy soils of the **Neuhorst-Newton Siding-Lakeland Group** (NUH,NWN,LKD) occur in the central and eastern portions of the municipality. Large delineations occur in the Sommerfeld-New Bercthal area and northwest of Altona. The soils of this group are less friable and permeable to water than the Neuenberg-Gnadenthal Group.

Portions of the northwest part of the municipality and scattered areas throughout the remainder are characterized by thin fine loamy (L-CL) surface deposits underlain by clay sediments within 1 meter. These imperfectly drained Black soils are in the **Graysville-Rignold Group** (GYV,RGD) and generally occur in landscapes bordering the deeper loamy and clayey sediments.

The soils in the southeastern corner of the municipality are developed on a thin veneer of clay sediments underlain by silty to silty clay materials which are in turn underlain by a clay substrate at or near a meter. These imperfectly drained Rego Black soils are in the **Dencross Group** (DCS). The topography of the area is characterized by low, near continuous ridges or silt bars oriented in a northwest-southeast direction. The silty soils are confined to the low ridges while deeper clay soils occupy the intervening lower lying positions. Silt bars of the Dencross Group also occur as thin slightly elevated linear to curvilinear ridges at scattered locations in the northeast portion of the municipality.

Local areas of sandy to coarse loamy soils of the **Reinland-Rosebank-Birkenhead Group** (RLD-RBK-BKA) occur at scattered locations in the southwest corner of the municipality. This group of imperfectly to well drained soils has developed on coarse textured lacustrine, deltaic and beach deposits. These soils are droughty and subject to wind erosion if the surface soil is not protected by crop residue. The Reinland soils developed on loamy very fine sand grading to fine sand are slightly less droughty than the Birkenhead soils. Rosebank soils are similar to the Reinland soils except for the occurrence of a clay substrate within a metre.

1.7 GEOLOGY

The bedrock geology of the R.M. of Rhineland is outlined in Figure 9. A major portion of the municipality is underlain by rock exposures of the Jurassic period. This includes dolomitic siltstone, sandstone and gypsum or anhydrite of the Amaranth formation; limestone, dolomite and shale of the Reston formation and sandstone, shale and limestone of the Melita formation. An exposure to the south of Altona includes dolomites of the Silurian period. The bedrock in the southeast corner of Rhineland is Ordovician in age. A sequence of formations occurs here, including the Stonewall, Stony Mountain and Red River. The individual members include a dolomitic, calcareous shale and limestone lithology.

These Post-Cambrian Paleozoic and Mesozoic rocks overlie the steeply tilted Precambrian bedrock. In southern Manitoba the thickness of the younger rocks at the outcrop edge is very shallow with the beds dipping southwest to their greatest depth in the

Figure 5. Location of Stratigraphic Cross-Sections in the R.M. of Rhineland

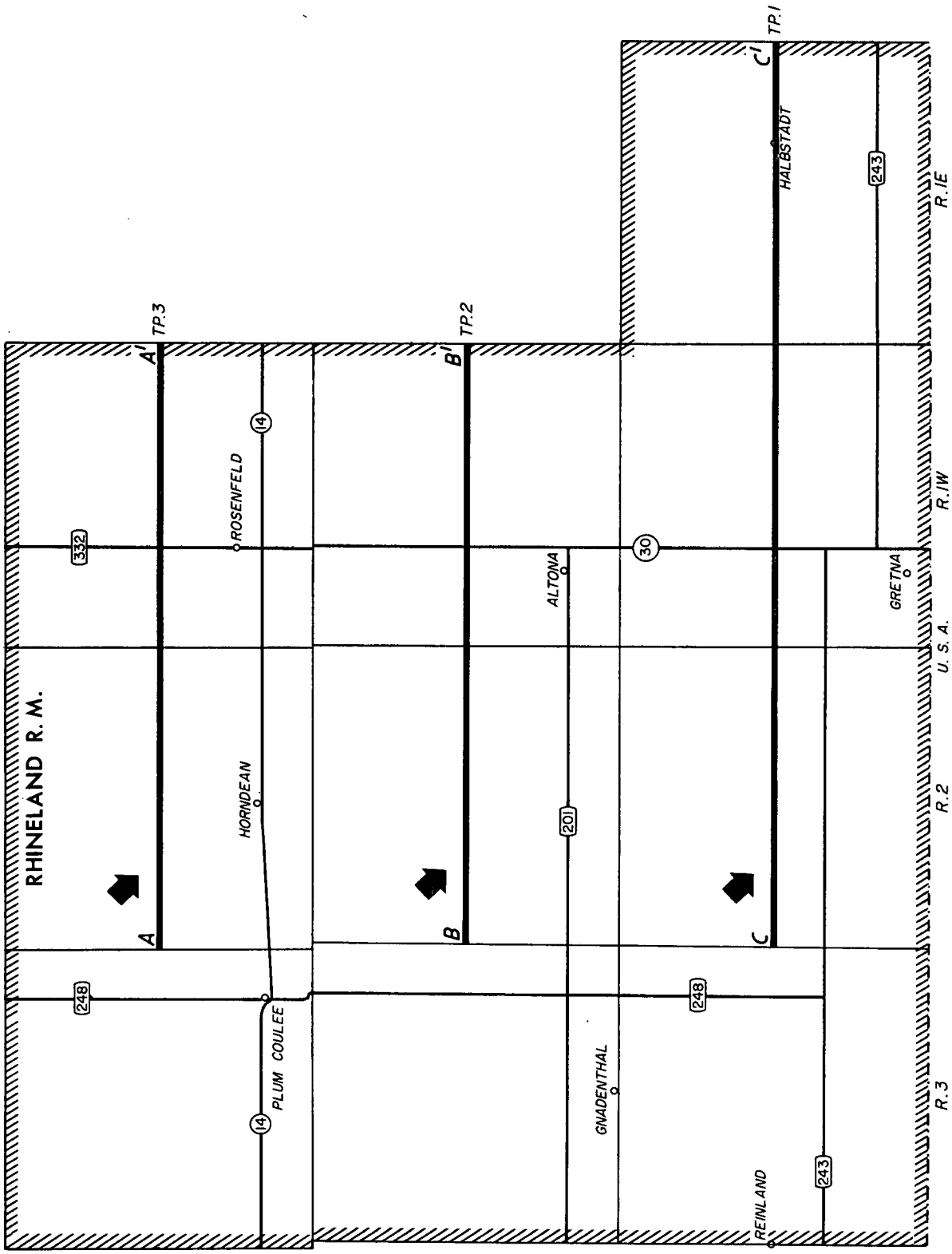


Figure 6. East-West Cross-Section (A-A') Showing the Surficial Stratigraphy in the Northern part of the R.M. of Rhineland

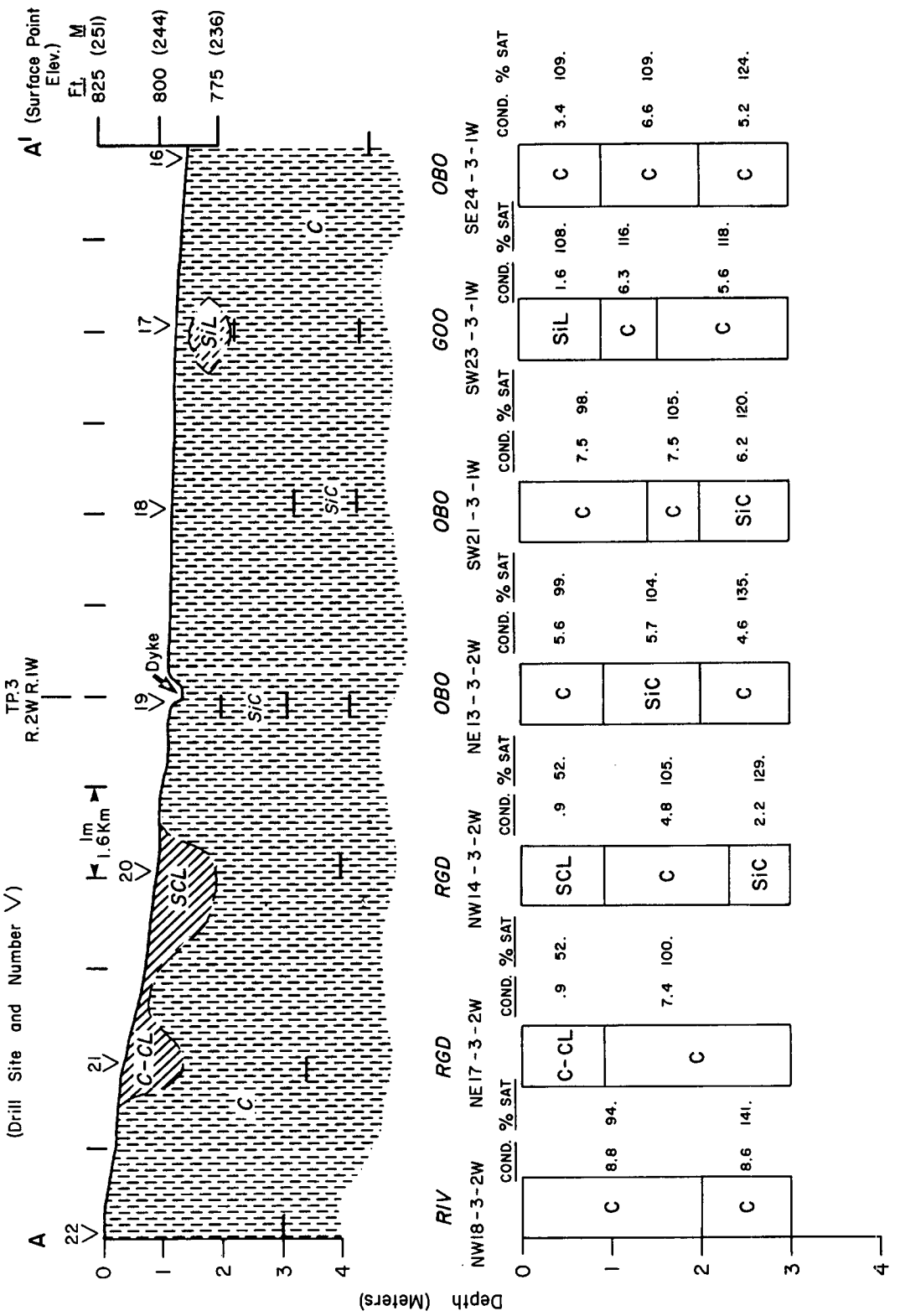


Figure 7. East-West Cross-Section (B-B') Showing the Surficial Stratigraphy in the Central part of the R.M of Rhineland

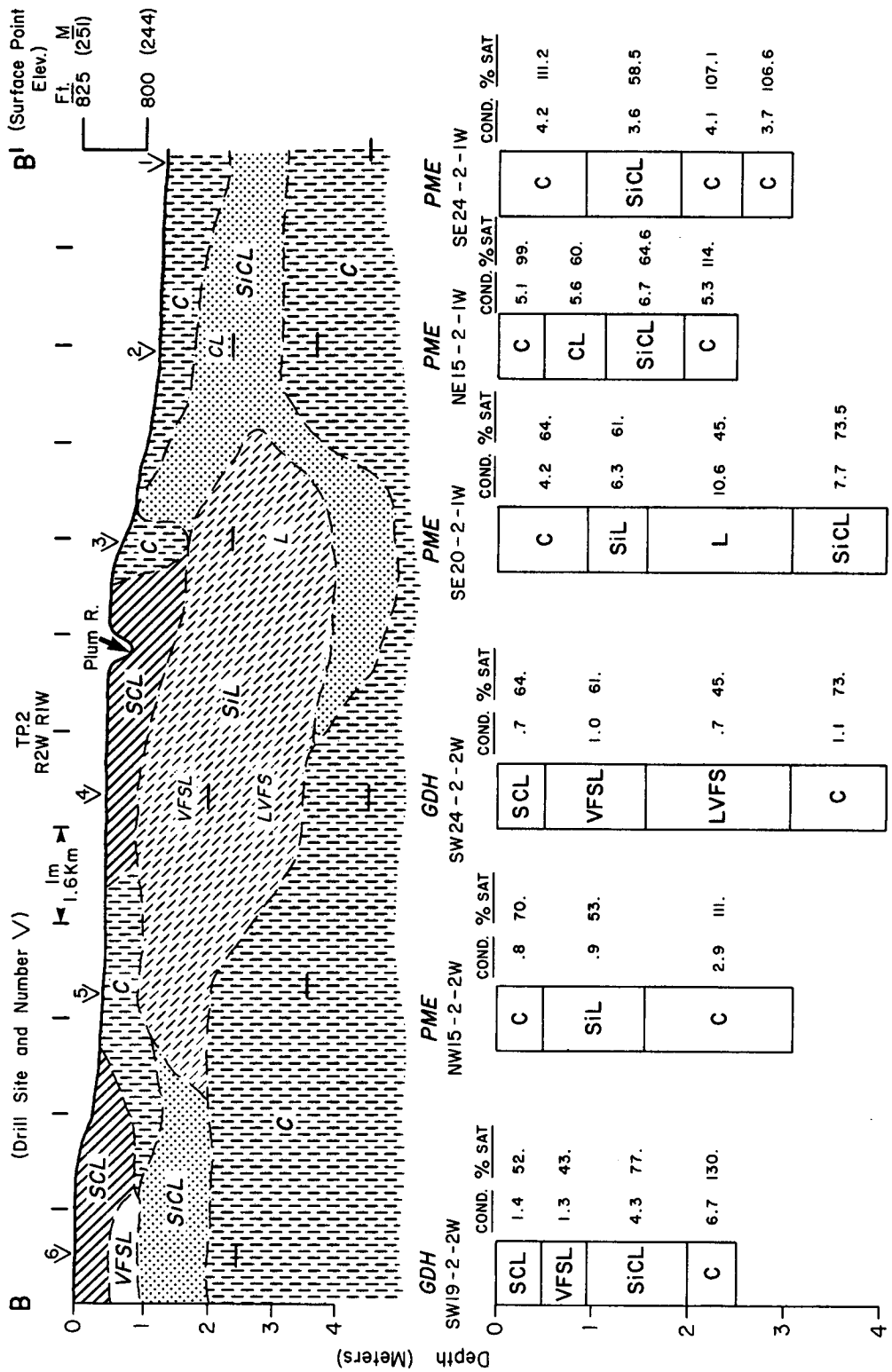


Figure 8. East-West Cross-Section (C-C') Showing the Surficial Stratigraphy in the Southern part of the R.M. of Rhineland

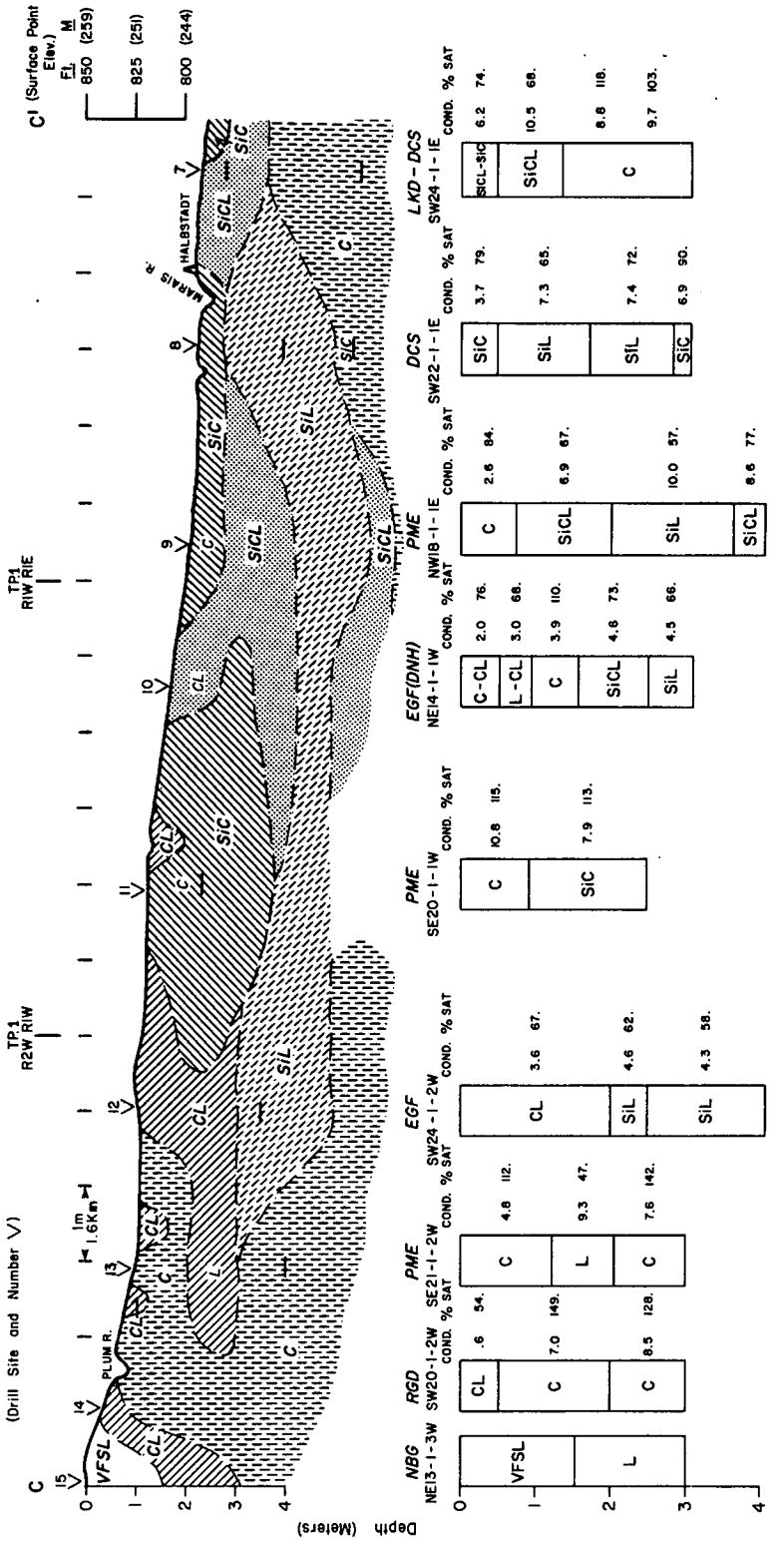
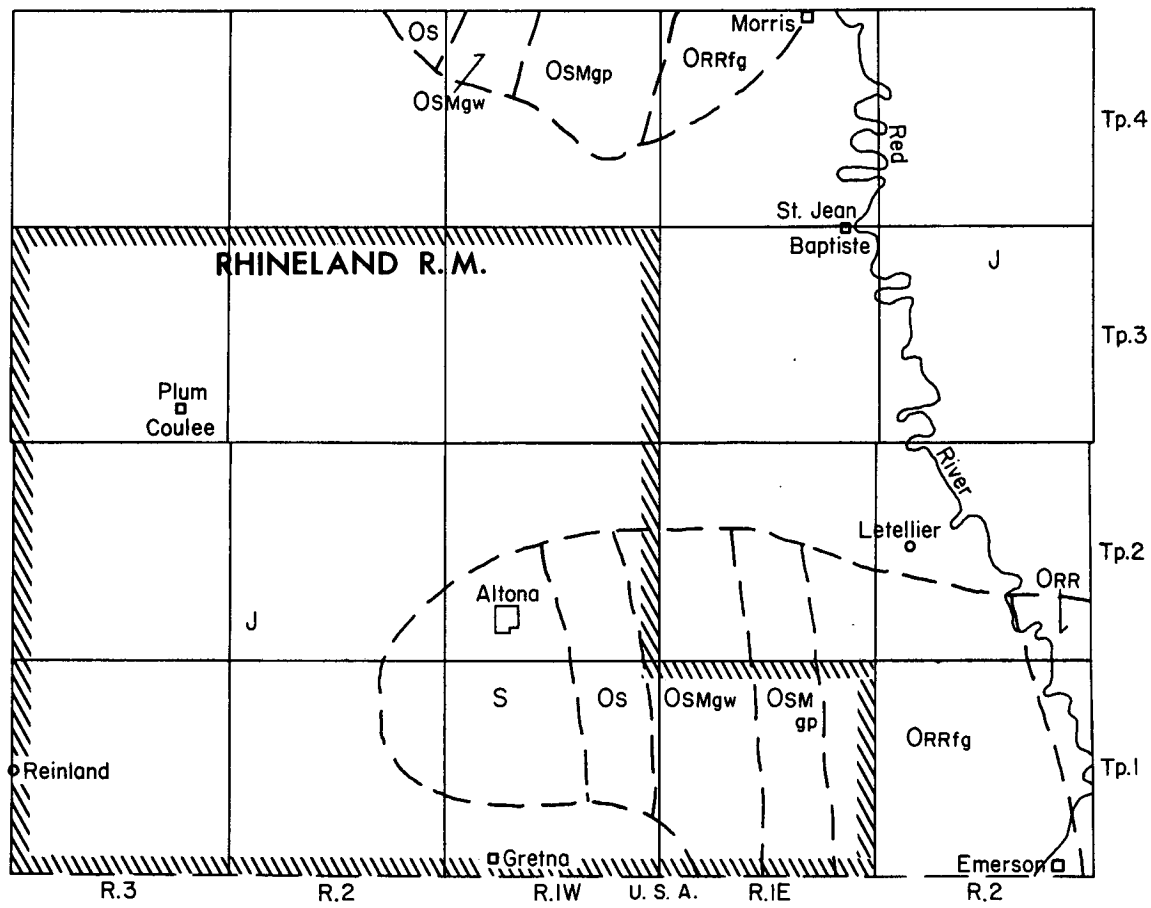


Figure 9. Geology of the Study Area



MESOZOIC
Jurassic

J — Amaranth Formation: red argillaceous dolomitic siltstone and sandstone overlain by gypsum or anhydrite. Reston Formation: limestone and dolomite, shale interbeds. Melita Formation: fine-grained sandstone, variegated shale, minor limestone.

PALEOZOIC
Silurian

S — Interlake Group: Fisher Branch, Inwood, Moose Lake, Atikameg, East Arm and Cedar Lake Formations: micritic, fossiliferous, stromatolitic and biostromal dolomites with several sandy/argillaceous marker beds.

Ordovician

Os — Stonewall Formation: dolomite, fine-grained, sparsely fossiliferous, in part conglomeratic. Medial sandy argillaceous marker may define Ordovician-Silurian boundary.

OSM $\frac{gp}{gw}$ — Stony Mountain Formation: Gunn and Penitentiary Members (gp) - calcareous shale, fossiliferous limestone and argillaceous dolomite. Gunton and William Members (gw) - nodular dolomite, and sandy argillaceous dolomite.

ORR fg — Red River Formation: Fort Garry Member (fg) - massive to laminated dolomite; minor argillaceous dolomite and high-calcium limestone; in part cherty.

extreme southwest corner of the province.

1.8 GROUNDWATER

In general, the potable groundwater supply in the R.M. of Rhineland is minimal, inadequate for local requirements and not uniformly distributed[2]. Fairly extensive areas of potable groundwater are available in township 1, a few occur in the central part (township 2) and are almost totally absent in the northern townships of the study. The near surface aquifers are formed by fine to very fine sand and silt layers interbedded in the surface deposits. The yield of these aquifers is very low and suitable for domestic or farm use only. Water quality ranges from good to very poor.

The only significant deep fresh water aquifer, formed by sand and gravel at 30 to 40 m below ground level, occurs in a narrow zone along the western boundary in Twp.1-Rge. 3W. This aquifer appears to correspond with the southern extension of the high yield Winkler aquifer. At this point the aquifer has thinned out and is only a few metres thick. The water quality in this aquifer ranges from good to poor depending on the location of the fresh and salt water boundary. Throughout most of the municipality, particularly in the northern part, shallow aquifers are uncommon and water in the deep aquifers is salty.

1.9 CLIMATE

Relative to worldwide climatic conditions, the study area is within the region designated as Dfb[3]. This is a humid continental, cold, snowy climate which is moist with warm summers. Located in the central part of the continent, this climate is in the polar front zone, the battleground of polar and tropical air masses. Seasonal contrasts are pronounced and weather highly variable. There is ample precipitation throughout the year which increases in summer. Cold winters are dominated by continental polar air masses.

In Manitoba, the relationships existing between climate, vegetation and soil are reflected in the Ecoclimatic regions[4] shown in Figure 10. A major portion of the R.M. of Rhineland corresponds with the Grassland Transition Region, subregion 4 (Gt_4) whereas the remaining northeast corner and extreme eastern edge are in subregion 1 (Gt_1). Generally the region is characterized by cool subhumid conditions, the warmest average temperature and longest growing season in the province. The Gt_4 subregion has a mean annual temperature of 2.8°C, an average of 122 frost free days and 1845 growing degree days >5°C. Average growing season precipitation is 328 mm. In comparison, the slightly cooler subregion (Gt_1) to the northeast has a mean annual temperature of 2.0°C, an average of 116 frost free days and 1743 degree days >5°C. The mean growing season precipitation is 321 mm, while the average annual is 507 mm.

The soil climate conditions in the study area are described as moderately cool to cool boreal, subhumid. These soils are characterized by a mean annual soil temperature of 5-8°C and a range in mean summer soil temperature between 12 and 18°C at the 50 cm depth.

Data generated by local meteorological stations at Altona and Gretna is more specific and representative of the study area. This information is presented in Table 2. The climatic parameters at the two stations correlate very well with ecoclimatic subregion Gt_4 and suggest a slightly more favorable climate due to their location at the southern extremity of the region. The regional climatic conditions over the project area are very conducive to a wide variety of crop production.

1.10 VEGETATION

The entire study lies within a narrow segment of the Grassland Region of Canada, located in the extreme south-central Red River Valley as delineated by Rowe[5]. The municipal boundary corresponds very closely to the southern expanse of the region.

The original vegetation of the study area has largely disappeared due to the extensive development of arable culture. The tall prairie grass, meadow-prairie grass and meadow grass associations have been replaced by crops and windbreaks. The native species which still occur as fringes along streams and intermittent water courses include oak, aspen, snowberry, hazel and dogwood on the better drained sites. Other species including elm, basswood, maple, cottonwood, box elder and ash with an undergrowth of willow and ferns mark the alluvial and floodplain deposits. Common grass and grass-like species found were blue grass, cord grass, june grass, sedges, spear grass and wheat grass.

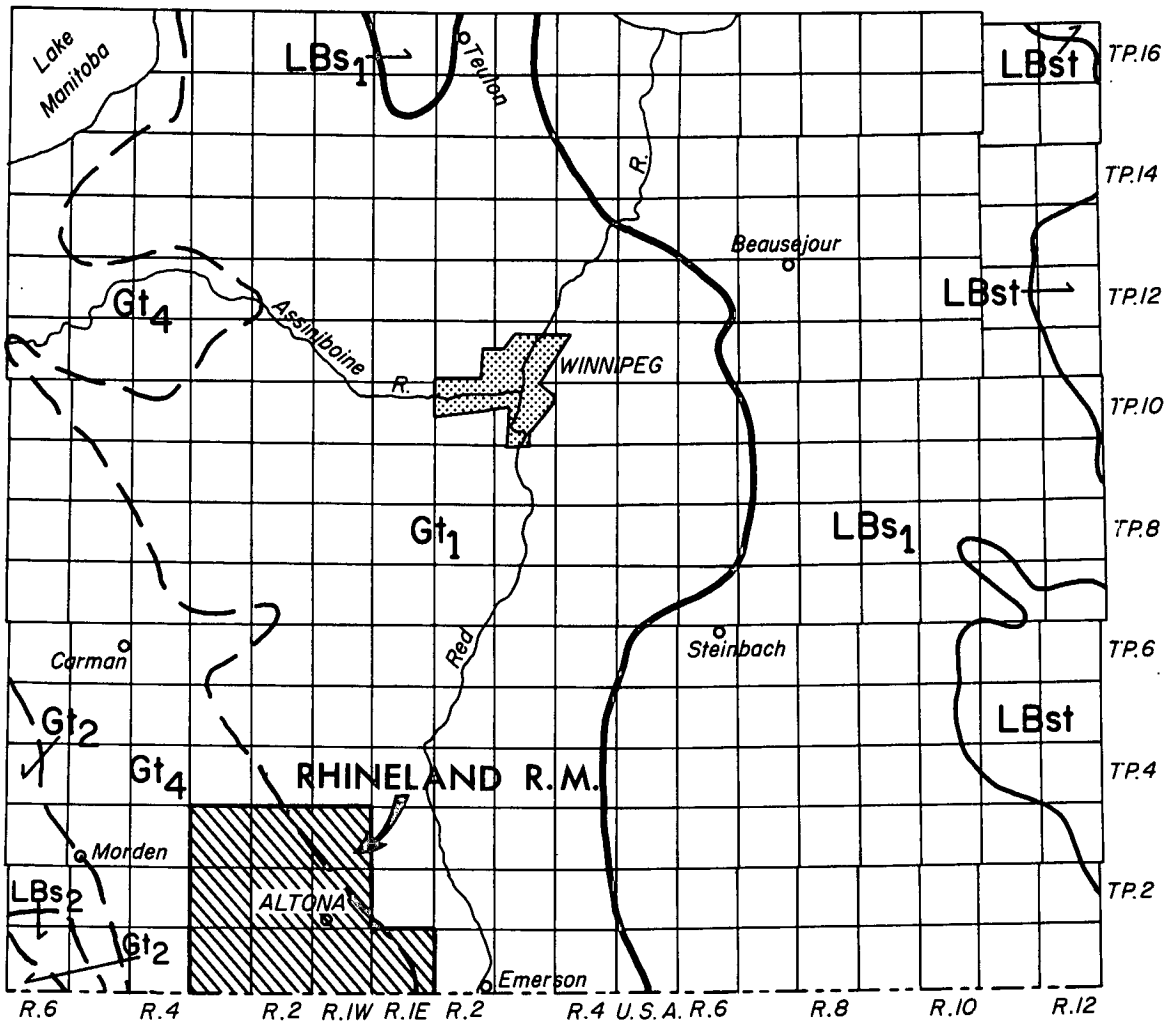
A striking feature of the landscape, particularly in the southern portion of the municipality, is the rows of trees which mark the village and farm sites. Many of these windbreaks were planted in the early days of settlement by the Mennonites who pioneered this area.

Table 2. Climatic Data from Stations[6] at Altona and Gretna

	Altona	Gretna
Mean Annual Temperature	2.8°C	3.2°C
Frost Free Period (Days, 0°C)	123	117
Last Frost (Spring)	May 18	May 24
First Frost (Fall)	Sept. 19	Sept. 19
Degree Days (above 5°C)	1888.	1903.
Total Precipitation	511 mm	473 mm
Mean Annual Rainfall	396 mm	360 mm
Mean Annual Snowfall	115 mm	116 mm
Corn Heat Units	2594	-

Figure 10. Ecoclimatic Regions of the Study

Ecoclimatic Region	Subregion	Dominant Soils	Soil Climate		Vegetation Zone
			Temperature Class	Moisture Subclass	
GRASSLAND TRANSITION	GT1,2,4	Chernozemic Black, Gleysols	Boreal, cool to moderately cool	Subhumid	Grassland and Aspen Parkland
LOW BOREAL subhumid	LBs1,2	Chernozemic Dark Gray Brunisolic Organic	Cryoboreal, moderately cold	Subhumid	Grassland Forest Transition
LOW BOREAL, subhumid transition	LBst	Brunisols Luvisols Chernozemic Dark Gray, Gleysols Organic	Cryoboreal, moderately cold	Humid to subhumid	Mixed Deciduous - Coniferous Forest



PART 2

2 METHODOLOGY

2.1 MAPPING

Soil mapping in this project was conducted by soil surveyors employing an intensive grid or systematic sampling method. Soil profiles were examined to a depth of one meter at sites approximately 150 meters apart along foot traverses that, in turn, were spaced approximately 0.8 km apart. In this project, the initial inspection point in each section was located 50 to 100 meters from a road allowance fence approximately .4 km from a selected corner of the section to be surveyed. The direction each traverse took was determined on the basis of maximizing the information that could be derived from the range of known soil-landscape variation in each section. Additional sites along road allowances were also examined to help locate soil boundaries between sections. This method of sampling provided approximately 25 to 30 inspection sites per section, or put another way, each site represented approximately 8 to 10 ha. This intensity of sampling permitted the confident delineation of soil mapping units comprised of narrowly defined soil types and other landscape features such as slope, stoniness and erosion on maps at a scale of 1:20,000 (3 inches equal one mile).

2.2 MAP UNITS

A map unit represents mappable portions of the soil landscape that together have characteristics and properties varying within more or less narrow limits that are determined by the intensity of the survey.

A map unit contains predominantly one or more than one soil or nonsoil individual plus a certain proportion (varying within prescribed limits) of unnamed and undescribed inclusions. They are delineated on the basis of the types and relative proportions of their soils or nonsoils, as well as on the basis of external criteria such as slope, stoniness or erosion.

Soil maps show the distribution of kinds of soils and, as such, serve as a link so that the knowledge gained in one locality about the usefulness or behaviour of a kind of soil can be extended to other bodies of the same soil.

A map unit comprises all delineations that contain exactly the same symbol. This includes all the characters denoting soils, nonsoils, phases and deciles. While they represent real portions of the landscapes, most map units are concepts because their total range of properties is made up of the aggregate of all their delineations and no one delineation will contain the full range of properties. The proportions of each of the component soils and nonsoils and undescribed inclusions may vary within reasonable limits from one delineation to another.

A map unit is named from its principal component soils or nonsoils. It is described in terms of the properties of these components, their relative proportions and other external land attributes. In this project, units are described in terms of named soil series and phases of soil series. The soil series is defined as a naturally occurring soil body such that any profile within that body has a similar number and arrangement of horizons whose colour, texture, structure, consistence, reaction and composition are within a narrowly defined range.

Map units will always contain small proportions of inclusions. These inclusions may be soil or nonsoil mapping individuals that are named and have their own map units elsewhere in the survey, or they may be rare or insignificant soils or nonsoils that are not recognized and named at all in the survey. They may, however, be mentioned in the description of soil types in the report.

2.3 SIMPLE AND COMPOUND MAP UNITS

There are two major types of map units: simple and compound. The difference between them is defined in terms of the proportion and contrast of their components.

A Simple Map Unit contains predominantly one soil or nonsoil. The proportion of its com-

ponents vary according to their areal extent and contrasting characteristics as they may affect soil management or use. Its components vary as follows: the predominant component comprises at least 65 percent with up to 35 percent of nonlimiting, similar components (components are alike in most properties and behaviour), or up to 25 percent of nonlimiting dissimilar components (components do not affect management of the map unit but have a significant number of properties that vary from the predominant component), or up to 15 percent of limiting, dissimilar components (components have many contrasting properties and usually affect management differently).

A Compound Map Unit contains predominantly two soils or nonsoils (or a combination of both). The proportions of the two major components may vary from one considerably exceeding the other to both being approximately equal. Complementary to the definition of a single map unit, the proportions of its components vary according to their areal extent and contrasting characteristics as they may affect soil management or use. Its major components vary as follows: if other components are similar and nonlimiting no single component represents more than 65 percent; or if other components are dissimilar and nonlimiting no single component represents 75 percent or more; or if other components are dissimilar and limiting no single component represents 85 percent or more.

A soil or nonsoil may occur in more than one compound unit. The complex nature of soil landscapes requires that the surveyor be allowed the freedom to describe their combinations as they occur. For the purpose of describing compound map units, components are considered dominant if they occupy over 40 percent of the unit, significant from 15-40 percent and minor if they occupy less than 15 percent. Minor components are described only if they are highly contrasting.

2.4 PHASES

It is frequently desirable to indicate by map unit symbol, a condition or quality of soil property or landscape feature that deviates significantly from the normal definition of map units. These indicated variations or phases of soil properties and landscape features, varying from delineation to delineation, significantly affect soil behaviour and land management or use.

It is not always easy to maintain a clear distinction between a soil phase and a land phase. Soil properties that are frequently used as phase criteria include texture depth, surface peat, salinity and physical disruption. Properties of land that are used include slope, wind and water erosion, stoniness, rockiness and altered drainage.

In this study the effect of four properties and land features are shown as a character in the denominator of the map unit symbol and described outside the main soil map legend. The four properties and features are erosion, slope class, degree of stoniness and salinity. The degree or magnitude of each is designated in the following manner;

Erosion

x - noneroded or minimal
1 - weakly eroded
2 - moderately eroded
3 - severely eroded
0 - overblown

Slope Class

x - 0 to 2% level to nearly level
c - 2 to 5% very gently sloping
d - 5 to 9% gently sloping
e - 9 to 15% moderately sloping
f - 15 to 30% strongly sloping
g - 30 to 45% very strongly sloping
h - 45 to 70% extremely sloping

Stoniness

x - nonstony
1 - slightly stony
2 - moderately stony
3 - very stony
4 - exceedingly stony
5 - excessively stony

Salinity

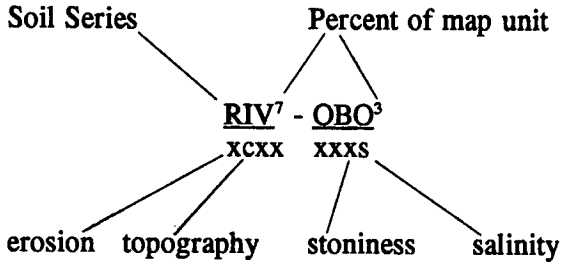
x - nonsaline (0-4 mS/cm)
x - slightly saline (4-8 mS/cm)
t - moderately saline (8-15 mS/cm)
u - strongly saline (> 15 mS/cm)

The convention employed to indicate these features in the map symbol is as follows:

If none of the above properties are observed to be significant, the map symbol representing the normal or unaffected soil series is used alone without modifiers.

If one or more phase features are recognized, the appropriate letter or number is placed below the soil series symbol in one of four designated locations in the map unit symbol. The designated order is erosion, slope class, stoniness and salinity. If a particular feature is not observed to be significant, an x is used in its appropriate designated location in the map symbol.

For example, the compound map unit coded:



is interpreted to mean that 70 percent of the mapping unit consists of Red River (RIV^7) series, having minimal or no erosion (x), very gently sloping (c) topography, non (x) stony, no salinity (x); and 30 percent Osborne (OBO^3) series having no erosion (x), level (x) topography, non stony (x) surface conditions and slightly (s) saline.

Variants

Variants included are subdivisions of a series based on slight variation in surface (15-25 cm) texture.

1 = Loam to Clay Loam Variant
2 = Clay Variant

Example: DHO_1, GDH_2

- Deadhorse, loam to clay loam surface
- Gnadenthal, clay surface

2.5 SAMPLING

During the course of field investigations and mapping, soil samples were taken at selected locations for soil characterization, and classification studies. Nineteen profiles were described in detail and sampled for soil characterization analysis (Appendix F). In areas where salinity was suspected to be a problem, soils were sampled at 10 to 25 cm and at 50 to 60 cm for electrical conductance measurements and soluble salt analysis. Relatively high levels of sodium sulphate have been analyzed in many of the samples. In addition grab samples were routinely taken for analysis including texture, pH, carbonate levels etc.

Twenty two sites were drilled and sampled to depths of up to 4 meters to provide additional information on physical and chemical characteristics of the parent material. The data from these "deep drill" investigations was used to develop 3 stratigraphic cross-sections of the surficial deposits in the municipality as shown in Part 1. Additional drill analysis data is provided in Appendix F. Soil water holding capacity data for selected soils in the R.M. of Rhineland is also given in Appendix F.

PART 3

3 DEVELOPMENT, CLASSIFICATION AND DESCRIPTION OF SOILS

3.1 SOIL DEVELOPMENT

The principal factors affecting soil formation are: the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; relief and drainage; the length of time the forces of soil formation have acted on the soil material; and influence resulting from the work of man. The characteristics of a soil at any given place are determined by the interaction of these soil forming factors.

Soil characteristics are observed in the soil profile. A profile is the sequence of natural layers or horizons observed in vertical cross-section extending from the surface down into the relatively unweathered and unaltered soil parent material. The main or master horizons have been designated by the letters A, B and C for mineral horizons. Horizon characteristics and combinations of these horizons form the basis for soil classification. The A and B horizons are a reflection of the active soil forming factors, climate and plant and animal life, chiefly plants operating on the parent material. Together the A and B horizons make up the solum. In general, A horizons or surface layers are subjected to the greatest amount of weathering and leaching and/or organic matter accumulation. The B horizons, lying immediately below the A horizon contain most of the material leached from the A horizons; ie. clay, organic matter, iron and aluminum.

In some soils B horizons consist mainly of material that has been altered only slightly by soil forming processes, but has not been translocated. The C horizons represent the relatively unaltered parent material from which the solum has developed.

Within a particular climatic zone, soils differ due to texture and mineralogical composition of the parent material. The soil profile that develops is also very much influenced by soil drainage and groundwater hydrology. Soils developed on sandy to loamy materials are more permeable to water and permit greater leaching of soluble and colloidal components as compared to clayey soils. Soil profiles developed on moderately calcareous sediments are generally deeper than soils developed on strongly calcareous sediments. Restrictions on normal soil development often result from periods of saturation in areas affected by surface ponding, lateral inflow, seepage or near surface groundwater. Under such conditions, leaching of soil material is minimal and in some cases, the translocation of soluble materials is towards the surface. Poor soil drainage associated with depressional areas alters the soil environment from an oxidative state to a reductive state depleted of oxygen. Such soils with restricted drainage are characterized by dull (gleyed) soil colours, the presence of reddish yellow or brown mottles of iron and manganese, the presence of lime carbonate and/or soluble salts near the surface and a high water table. Very poorly drained depressional sites are saturated throughout the year and soils are often characterized by accumulation of shallow organic materials.

In the study area the degree of soil development is related to the regional climate which affects the degree of leaching, translocation and accumulation of soluble and colloidal fractions of the soil. Soil development has taken place under a moderately cool to cool, subhumid Boreal climate which has produced growing conditions conducive to the establishment of tall prairie grasses, meadow grasses, aspen-oak fringes and associated grassland vegetation. Under these conditions, the dominant soils developed in this area are Chernozemic Blacks on the well to imperfectly drained positions and Humic Gleysols in the poorly drained areas. The imperfectly drained Gleyed Blacks and Gleyed Rego Blacks are dominant. Profile development on both poorly and imperfectly drained soils has been restricted by soil moisture regime and proximity of groundwater to the soil surface. Cumulic Regosols of relatively youthful origin commonly occur in areas adjacent to the major rivers and streams in the study area. Soils along creeks have been influenced by periodic flooding and accretion of sediments on the soil surface.

Of particular interest in the study area is the development of some Solonetzic type soils in the south-central part of the study around Gretna and in the northern township. The profile development ranges from a Gleyed Solonetzic Black intergrading to a Gleyed Black Solonetz. These soils have developed from parent materials that were more or less uniformly salinized with salts high in sodium. As a result these soils have a very tough and compact amorphous structure which makes tillage and seedbed preparation very difficult.

3.2 SOIL SERIES DESCRIPTIONS

Soil series for the study area are described in alphabetical order and include a general description of the genetic profile type, texture, parent material, topography and drainage. General statements on the distribution, surface runoff, stoniness and vegetation characteristics are also given. For additional information and discussion relative to soils of the area, particularly chemical and physical soil analyses, refer to the "Soils of the Morden-Winkler Area" Report No. 18, 1973, which includes coverage of Twps. 1, 2 and 3 of Range 3W, in the R.M. of Rhineland. A convenient, abbreviated key form of reference on the relationship of soil series in the study to soil drainage, subgroup and parent material is provided in Table 3. A more comprehensive grouping of soils and parent materials is presented in Table 4.

Table 3. Key to the Soil Series of the R.M of Rhineland in the Grassland Transition Ecoclimatic Region (Subregions 1 and 4). Arranged in Relation to Soil Moisture Class, Subgroup and Parent Material

Soil Moisture Class	Subgroup	Parent Materials: Fluvial (Outwash) — Sandy-Skeletal (S and Gr)	Lacustrine (Gt_4) — Coarse Loamy (FSL,VFS,LVFS)	Lacustrine (Gt_4) — Coarse L. to Sandy over Clayey (SL,LVFS,FS, LFS/C,SiC)	Lacustrine (Gt_4) — Loamy over C. Loamy to Sandy (VFSL,L,SiL/ SL,LVFS,FS,LS)	Lacustrine (Gt_4) — Loamy grading to Fine Loamy (VFSL,L,SiL/ SCL,CL,SiCL)	Lacustrine (Gt_4) — Fine Loamy (CL,SiCL,SCL)	Lacustrine (Gt_4) — Loamy over Clayey (L,SiL,VFSL,CL,SiCL,SCL/ C,SiC)
Well	Cumulic Regosol							
	Orthic Black		Hochfeld(HHF)	Hibsin(HIN)	Rosengart(RSG)	Reinfeld(RFD)	Eigenhof(EGF)	Denham(DNH)
	Calcareous Black	Birkenhead(BKA)						
Imperfect	Gleyed Cumulic Regosol							
	Gleyed Black		Kronstal(KOT)	Elm Creek(EEK)	Jasset(JST)		Rathwell(RWL)	Rignold(RGD)
	Gleyed Rego Black		Reinland(RLD)	Rosebank(RBK)	Neuenberg(NBG)	Gnadenthal(GDH)	Neuhorst(NUH)	Graysville(GYV)
	Gleyed Solonetzic Black							
Poor	Rego Humic Gleysol		Osterwick(OWK)			Blumenfeld(BNF)		Edkins(EDK)

Soil Moisture Class	Subgroup	Parent Materials: Lacustrine (Gt_4) — Fine Loamy over C. Loamy to Sandy (CL,SiCL,SCL/ VFS,SL,FS,LFS)	Lacustrine (Gt_4) — Clayey over stratified Clayey (C,SiC/C, SiL,SiCL,SiC)	Lacustrine (Gt_4) — Clayey over stratified C. Loamy to Sandy (C,SiC/L,SiL, SL,VFS,FS,LS)	Alluvium (Gt_4) — Loamy stratified (SL,L,SiL, CL,SiCL,SCL)	Alluvium (Gt_4) — Clayey (Shaly) (C,SiC,HC)	Lacustrine (Gt_1) — Fine Loamy (CL,SiCL,SCL)	Lacustrine (Gt_1) — Clayey over Loamy (C,SiC/SiL, Si,SiCL)	Lacustrine (Gt_1) — Clayey (C,SiC,HC)	Alluvium (Gt_1) — Clayey stratified (C,SiC,SC,CL)
Well	Cumulic Regosol									Black Lake(BCK)
	Orthic Black	Edenburg(EBG)	Winkler(WIK)	Jordan(JOD)					Myrtle(MYT)	
	Calcareous Black									
Imperfect	Gleyed Cumulic Regosol				Chortitz(CTZ)	Blumengart(BMG)				Seine River(SRE)
	Gleyed Black		Plum Coulee(PME)	Horndean(HND)				Hoddinott(HDN)	Scanterbury(SCY)	
	Gleyed Rego Black	Newton Siding(NWN)	Deadhorse(DHO)	Dugas(DGS)			Lakeland(LKD)	Dencross(DCS)	Red River(RIV)	
	Gleyed Solonetzic Black		Gretna(GRA)						Morris(MRS)	
Poor	Rego Humic Gleysol				Loewen(LEW)	Blumenort(BUM)		Glenmoor(GOO)	Osborne(OBO)	Dufresne(DFS)

TABLE 4

Table 4. Parent Materials and Related Soils of the Study Area

Soils of the Grassland Transition Ecoclimatic Subregion, Gt_4

A. Fluvial (Outwash) Materials(Gt_4)

1. Soils developed on sandy to sandy-skeletal (S,LS,GrS), moderately to strongly calcareous beach and outwash deposits.

   a) Well Drained

   - Birkenhead series (Calcareous Black) — BKA

B. Lacustrine Materials (Gt_4)

1. Soils developed on coarse loamy (VFS,FSL,LVFS), moderately to strongly calcareous, lacustrine deposits.

   a) Well drained

   - Hochfeld series (Orthic Black) — HHF

   b) Imperfectly drained

   - Kronstal series (Gleyed Black) — KOT
   - Reinland series (Gleyed Rego Black) — RLD

   c) Poorly drained

   - Osterwick series (Rego Humic Gleysol) — OWK

2. Soils developed on coarse loamy to sandy (SL,LVFS,FS,LFS), moderately to strongly calcareous, lacustrine and deltaic sediments overlying calcareous lacustrine clay within a meter.

   a) Well Drained

   - Hibsin series (Orthic Black) — HIN

   b) Imperfectly drained

   - Elm Creek series (Gleyed Black) — EEK
   - Rosebank series (Gleyed Rego Black) — RBK

3. Soils developed on loamy (VFSL,L,SiL), moderately to strongly calcareous, deltaic and lacustrine sediments, over coarse loamy to sandy deposits within a metre.

   a) Well drained

   - Rosengart (Orthic Black) — RSG

   b) Imperfectly drained

   - Jasset series (Gleyed Black) — JST

- Neuenberg series (Gleyed Rego Black) NBG

4. Soils developed on loamy (VFSL,L,SiL) grading to fine loamy, moderately to strongly calcareous, deltaic and lacustrine sediments.

   a) Well drained

   - Reinfeld series (Orthic Black) RFD

   a) Imperfectly drained

   - Gnadenthal series (Gleyed Rego Black) GDH

   c) Poorly drained

   - Blumenfeld series (Rego Humic Gleysol) BNF

5. Soils developed on fine loamy (CL,SiCL,SCL), moderately to strongly calcareous lacustrine and deltaic sediments.

   a) Well Drained

   - Eigenhof series (Orthic Black) EGF

   b) Imperfectly Drained

   - Rathwell series (Gleyed Black) RWL
   - Neuhorst series (Gleyed Rego Black) NUH

6. Soils developed on loamy (L,SiL,VFSL,CL,SiCL), moderately to strongly calcareous, lacustrine sediments overlying calcareous, clayey (SiC,C) lacustrine deposits within a meter.

   a) Well Drained

   - Denham series (Orthic Black) DNH

   b) Imperfectly Drained

   - Rignold series (Gleyed Black) RGD
   - Graysville series (Gleyed Rego Black) GYV

   c) Poorly drained

   - Edkins series (Rego Humic Gleysol) EDK

7. Soils developed on moderately to strongly calcareous, fine loamy (CL,SiCL,SCL) deltaic and lacustrine sediments over moderately calcareous, coarse loamy to sandy (VFS,SL,FS,LFS) sediments.

   a) Well drained

   - Edenburg series (Orthic Black) EBG

   b) Imperfectly drained

- Newton Siding series (Gleyed Rego Black) NWN

8. Soils developed on clayey (C,SiC) over stratified clayey (C,SiL,SiCL,SiC), moderately to strongly calcareous lacustrine and deltaic sediments.

a) Well drained

- Winkler series (Orthic Black) WIK

b) Imperfectly drained

- Plum Coulee series (Gleyed Black) PME
- Deadhorse series (Gleyed Rego Black) DHO
- Gretna series (Gleyed Solonetzic Black to Gleyed Black Solonetz) GRA

9. Soils developed on clayey (C,SiC), moderately to strongly calcareous lacustrine sediments overlying stratified coarse loamy to sandy (L,SiL,SL,VFS,FS,LS) strata.

a) Well drained

- Jordan series (Orthic Black) JOD

b) Imperfectly drained

- Horndean series (Gleyed Black) HND
- Dugas series (Gleyed Rego Black) DGS

C. Alluvium (Gt_4)

1. Soils developed on stratified, loamy (SL,L,SiL,CL,SiCL,SCL), weakly to moderately calcareous, recent alluvium.

a) Imperfectly drained

- Chortitz series (Gleyed Cumulic Regosol) CTZ

b) Poorly drained

- Loewen series (Rego Humic Gleysol) LEW

2. Soils developed on clayey, recently deposited, weakly to moderately calcareous, shaly alluvium.

a) Imperfectly drained

- Blumengart series (Gleyed Cumulic Regosol) BMG

b) Poorly drained

- Blumenort series (Rego Humic Gleysol) BUM

Soils of the Grassland Transition Ecoclimatic Subregion, Gt_1

D. Lacustrine Deposits (Gt_1)

1. Soils developed on very strongly to extremely calcareous, fine loamy (CL,SiCL,SCL) lacustrine

sediments.

a) Imperfectly drained

- Lakeland series (Gleyed Rego Black) LKD

2. Soils developed on a thin mantle of moderately calcareous, clayey sediments over very strongly calcareous, loamy (Si, SiL,SiCL) materials. These deposits are generally underlain by lacustrine clay at about a metre.

a) Well drained

- Fort Garry (Orthic Black) FTY

b) Imperfectly drained

- Hoddinott series (Gleyed Black) HDN
- Dencross series (Gleyed Rego Black) DCS

c) Poorly drained

- Glenmoor series (Rego Humic Gleysol) GOO

3. Soils developed on deep, moderately to strongly calcareous clayey (C,SiC) lacustrine sediments.

a) Well drained

- Myrtle series (Orthic Black) MYT

b) Imperfectly drained

- Scanterbury series (Gleyed Black) SCY
- Red River series (Gleyed Rego Black) RIV
- Morris series (Gleyed Solonetzic Black) MRS

c) Poorly drained

- Osborne series (Rego Humic Gleysol) OBO

E. <u>Alluvium (Gt_1)</u>

1. Soils developed on moderately to strongly calcareous, clayey (C,SiC,SiCL), stratified, recent alluvial deposits.

a) Well Drained

- Black Lake series (Cumulic Regosol) BCK

b) Imperfectly drained

- Seine River series (Gleyed Cumulic Regosol) SRE

c) Poorly drained

- Dufresne series (Rego Humic Gleysol) DFS

Black Lake Series (BCK)

The Black Lake series consists of well drained Cumulic Regosol soil developed on moderately to strongly calcareous, deep stratified, clayey, fluvial deposits. These soils occur in upper positions of gentle slopes on terrace landscapes and have moderately slow permeability, moderate surface runoff and a low to medium water table during the growing season. Black Lake soils are noneroded, nonstony and nonsaline. They have medium to high available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes elm, maple, box-elder, cottonwood and some oak. The majority of these soils are currently used for agriculture or are in their native treed state and are subject to flooding.

In a representative profile of Black Lake soil the solum is approximately 15 cm thick. The profile is characterized by a gray, weakly calcareous, SiC, Ah horizon, 0 to 15 cm thick, with a gray (10YR 5/1d), weakly calcareous, SiC, Ck1 horizon, 15 to 30 cm, a gray to light gray, moderately calcareous, SiC, Ck2 horizon, 30 to 50 cm with SiL to SiCL strata and a brownish gray, moderately calcareous, SiC, Ck3 horizon 50 to 90 cm. The parent material is typically stratified.

Black Lake soils occur in close association with Seine River and Hodgson soils. They are similar to Hodgson soils by having a similar position and mode of deposition but differ from Hodgson soils because of a heavier texture. Black Lake soils were previously mapped as Riverdale in the Morris Map Sheet, Report No. 5, 1953.

Birkenhead Series (BKA)

The Birkenhead series is a Calcareous Black soil developed on moderately well drained, moderately to strongly calcareous, stratified sandy (LS, S, CS) and gravelly deposits. There is usually a surface mantle ranging in texture from loamy fine sand to sand over the coarser textured materials. These soils occur on gently sloping, stone-free, northwest-southeast trending beach ridges formed by glacial Lake Agassiz below the Manitoba Escarpment. Surface runoff is moderate to slow, and permeability is rapid. The native prairie grasses once associated with these soils, have been mostly replaced by cultivated grasses and legumes such as brome grass and alfalfa.

The Birkenhead soil profile has a very dark gray Ah horizon, 15 to 30 cm thick; a weakly calcareous, stratified, brown Bmk horizon, 10 to 20 cm thick, and a pale brown, moderately to strongly calcareous C horizon. This soil differs from the similar Hochfeld series in having coarser textures, more rapid drainage and having a calcareous Bm horizon.

These soils are strongly to severely affected by droughtiness as a result of their rapid permeability and low water-holding capacity.

Blumengart Series (BMG)

The Blumengart series consists of imperfectly drained Gleyed Cumulic Regosol soil developed on weakly to moderately calcareous, clayey (SiC,C), recent fluvial deposits. Blumengart soils have been prone to inundation, but improved drainage and flood control measures has decreased the flooding hazard in recent years. These soils occur in level to depressional positions of level slopes on floodplain landscapes and have slow to very slow permeability, slow surface runoff, and a high water table during the growing season. Blumengart soils are noneroded, nonstony, and frequently slightly saline. They have a high available water holding capacity, low organic matter content, and medium natural fertility. Native vegetation includes tall prairie grasses, willows and shrubs. The majority of these soils are currently cultivated.

In a representative profile of Blumengart soil there is only a very weakly developed solum. The profile is characterized by a dark gray Ah horizon, 10 to 18 cm thick, and a gray to dark gray Ck horizon, with prominent iron mottles. A typical profile also contains thin strata of lighter textured former Ah horizons in the subsoil.

Blumengart soils occur in close association with Blumenort soils. They are similar to Chortitz soils by having an imperfectly drained Regosol profile but differ from them in having a much heavier clay texture. Blumengart soils were previously mapped as immature associates of the Gretna Association in the South-Central (1943) soil report.

Blumenfeld Series (BNF)

The Blumenfeld series consists of poorly drained Rego Humic Gleysol soil developed on moderately to strongly calcareous,loamy (VFSL,L,SiL,SiCL,CL), fluvial and lacustrine deposits. These soils occur in level to depressional positions of level slopes on level landscapes and have moderately slow permeability, very slow surface runoff, and ponding or a high water table

during the growing season. Blumenfeld soils are noneroded, nonstony, and frequently slightly saline. They have a medium available water holding capacity, medium organic matter content, and low natural fertility. Native vegetation includes sedges, reeds, rushes and meadow grasses. The majority of these soils are currently in native vegetation.

In a representative profile of Blumenfeld soil the solum is approximately 40 cm thick. The profile is characterized by a carbonated, very dark gray Ah horizon, 25 to 40 cm thick, a thin, dark grayish brown AC horizon, 10 to 15 cm thick with prominent mottles, and a light gray Ck horizon with prominent iron mottles. A typical profile also contains a Cca horizon of lime accumulation.

Blumenfeld soils occur in close association with Gnadenthal and Reinfeld soils. They are similar to Edkins soils by having a poorly drained profile in loamy deposits but differ from them in having loamy substrate while Edkins soils are clayey at depth. Blumenfeld soils were previously mapped as meadow associates of the Altona Association in the Morris Map Sheet, Report No. 5, 1953.

Blumenort Series (BUM)

The Blumenort series consists of poorly drained Rego Humic Gleysol soil developed on moderately calcareous, deep, stratified, clayey (SiC,C), recent alluvial deposits in flood prone areas along stream channels at the base of the Manitoba Escarpment. These soils occur in depressional positions of nearly level slopes on level landscapes and have very slow permeability, slow surface runoff, and a high water table during the growing season. Blumenort soils are noneroded, nonstony, and frequently saline. They have a high available water holding capacity, high organic matter content, and low natural fertility. Native vegetation includes sedges, rushes, reeds and willows. The majority of these soils are currently drained to reduce the hazard of flooding and used for cereal crop production.

In a representative profile of Blumenort soil the solum is approximately 20 cm thick. The profile is characterized by a very dark gray, calcareous Ah horizon, 10 to 18 cm thick, with slight salinity, a thin transitional AC horizon, 5 to 10 cm thick, and a dark olive gray Ck horizon, with numerous fine distinct mottles. A typical profile also contains light gray gypsum crystals in the C horizon.

Blumenort soils occur in close association with Blumengart soils. They are similar to Osborne soils by having a poorly drained profile in clayey soil. Blumenort soils were previously mapped as Meadow associates of the Gretna Association in the South-Central (1943) soil report.

Chortitz Series (CTZ)

The Chortitz series consists of an imperfectly drained Gleyed Cumulic Regosol soil developed on moderately calcareous, deep, stratified, loamy (L,CL,SiCL), recent alluvial deposits. Lighter strata of fine sand to sandy loam or heavier strata of silty clay to clay can also occur. These soils occur in middle positions of very gentle slopes on floodplain landscapes and have moderately slow permeability, slow surface runoff, and a high water table during the growing season. Chortitz soils are flood-prone, nonstony, and occasionally slightly saline. They have medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation includes willows, shrubs, tall prairie and meadow grasses. The majority of these soils are currently in natural vegetation.

In a representative profile of the Chortitz soil the weakly developed profile is characterized by a dark gray, calcareous Ap horizon, 10 to 18 cm thick, with granular structure, and a dark grayish brown to pale brown Ck horizon that is moderately calcareous and moderately or weakly saline. A typical profile also contains numerous fine mottles and gypsum crystals.

Chortitz soils occur in close association with Loewen soils. They are similar to Levine soils by having a Gleyed Cumulic Regosol profile developed in recent alluvium but differ from them in occurring in a slightly warmer and more moist climatic area below the Manitoba Escarpment. Chortitz soils were previously mapped as associates of the Riverdale Association in the Winnipeg-Morris (1953) soil report.

Dencross Series (DCS)

The Dencross series consists of imperfectly drained Gleyed Rego Black soils developed on (< 1 m) of moderately to strongly calcareous, shallow clayey, lacustrine deposits over very strongly to extremely calcareous, silty, lacustrine deposits. These soils occur in mid to upper positions of level to very gentle slopes on level to undulating landscapes and have slow to moderate permeability, slow surface runoff and a medium water table during the growing season. Dencross soils are non to slightly eroded, nonstony and may be saline. They have

medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes prairie grasses, aspen and willow. The majority of these soils are currently used for crop production.

In a representative profile of a Dencross soil the solum is approximately 40 cm thick. The profile is characterized by a thin, very dark gray, clay Ah horizon, 15 to 25 cm thick; a moderately calcareous, dark gray, clay, AC horizon, 15 to 20 cm thick; a light gray, clay to silty clay, moderately calcareous Ckgj horizon, 20 to 30 cm thick and a light olive brown, very strongly calcareous, silt loam to silty clay loam 2Ckgj horizon. The parent material is usually clayey over silty. A typical profile also contains an substrate of clay below the silty strata at or below 1 m.

Dencross soils occur in close association with Hoddinott and Red River soils. They are similar to Hoddinott soils by having a silty subsoil but differ from Red River soils which are more uniformly clayey throughout. Dencross soils were previously mapped as part of the Emerson (heavy) Association in the Morris Map Sheet (Report No. 5, 1953).

Dufresne Series (DFS)

The Dufresne series consists of poorly drained Rego Humic Gleysol soils developed on strongly calcareous, deep stratified, clayey, alluvial deposits. These soils occur in low to depressional positions along stream channels and have slow permeability, very slow surface runoff and a high water table during the growing season. Dufresne soils are noneroded, nonstony and nonsaline. They have medium to high available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes sedge, rush and willow. The majority of these soils are currently used for natural grazing and woodland.

In a representative profile of Dufresne soil the solum is approximately 20 cm thick. The profile is characterized by a thin, dark gray, clay, Ah horizon, 15 to 25 cm thick, with a variable, stratified, strongly calcareous, clay to silty clay mottled Ckg horizon with thin former Ah (buried) horizons in the stratified layers. The parent material is typically stratified clayey sediments.

Dufresne soils occur in close association with Seine River soils. They are similar to Seine River soils by having similar textures but differ because of having poorer drainage. Dufresne soils were previously mapped as Riverdale soils in the Winnipeg Map Sheet (Report No. 5, 1953).

Dugas Series (DGS)

The Dugas series consists of imperfectly drained Gleyed Rego Black soil developed on a mantle (40 to 70 cm) of moderately to strongly calcareous, shallow, uniform, clayey (SiC,C), lacustrine deposits over moderately to strongly calcareous, deep, stratified, sandy (FS,LFS,S), and loamy (L,SiL,CL), lacustrine, deposits.

These soils occur in middle positions of very gentle slopes on level landscapes and have very slow over moderately slow permeability, moderate surface runoff, and a high water table during the growing season. Dugas soils are noneroded, nonstony, and occasionally slightly saline. They have a high available water holding capacity, high organic matter content, and medium natural fertility. Native vegetation includes aspen groves, shrubs, tall prairie and meadow grasses. The majority of these soils are currently cultivated for grain production.

In a representative profile of Dugas soil the solum is approximately 15 cm thick. The profile is characterized by a black Ap or Ah horizon, 12 to 15 cm thick, a calcareous, very dark grayish brown AC horizon, 10 to 20 cm thick, a dark grayish brown Ckgj horizon, 15 to 25 cm thick, and a light olive brown IICkg horizon, with many distinct reddish brown mottles.

They are similar to Deadhorse soils by having a Gleyed Rego Black profile and clayey surface mantle but differ from them in having loamy substrata rather than a fine loamy to clayey substrate. Dugas soils were previously mapped as Black Meadow associates of the Horndean Association in the Morris Map Sheet (1953).

Deadhorse Series (DHO)

The Deadhorse series consists of imperfectly drained Gleyed Rego Black soil developed on moderately to strongly calcareous, deep, weakly stratified, clayey (SiC,C), fluvial and lacustrine deposits. Thin strata of silt loam to clay loam often occur within 1-2 meters of the surface. These soils occur in middle positions of level to very gentle slopes on undulating landscapes and have very slow permeability, slow surface runoff, and a high water table during the growing season. Deadhorse soils are noneroded, nonstony, and frequently slightly saline. They have a high available water holding

capacity, high organic matter content, and medium natural fertility. Native vegetation includes tall prairie grasses, aspen and oak. The majority of these soils are currently cultivated for grain crop production.

In a representative profile of Deadhorse soil the solum is approximately 20 cm thick. The profile is characterized by a very dark gray Ah horizon, 12 to 25 cm thick, a carbonated, dark gray to gray AC horizon, 8 to 20 cm thick and a Ckgj horizon with faint mottles.

Deadhorse soils occur in close association with Winkler and Plum Coulee soils, they are similar to Plum Coulee soils by having an imperfectly drained, clayey profile but differ from them in having no Bm horizon. Deadhorse soils were previously mapped as clayey Black Meadow associates of the Horndean Complex in the Morris Map Sheet (1953).

Denham Series (DNH)

The Denham series consists of moderately well to well drained Orthic Black soil developed on a thin mantle (60 to 90 cm) of moderately to strongly calcareous, shallow, loamy (VFSL,L,SiL,CL,SiCL), lacustrine sediments over moderately to strongly calcareous, deep, clayey (SiC,C,SC), lacustrine deposits. These soils occur in upper positions of very gentle slopes on undulating landscapes and are characterized by moderately permeable loams over slowly permeable clays, moderate to moderately rapid surface runoff, and a low water table during the growing season. Denham soils are noneroded, nonstony, and nonsaline. They have medium available water holding capacity, high organic matter content, and high natural fertility. Native vegetation includes aspen, oak, shrubs and prairie grasses. The majority of these soils are currently cultivated for grain crop production.

In a representative profile of Denham soil the solum is approximately 50 cm thick. The profile is characterized by a very dark gray to black Ap horizon, 20 to 30 cm thick, a very dark grayish brown to brown Bm horizon, 25 to 35 cm thick, a weakly calcareous BC horizon, 5 to 10 cm thick, and a yellowish brown to pale brown, moderately to strongly calcareous C horizon. The parent material is typically faintly mottled at depth. Denham soils occur in close association with Rignold, Graysville and Edkins soils. They are similar to Hibsin soils by having an Orthic Black profile and clayey substrate but differ from them in having a loamy surface mantle rather than a coarse loamy mantle. Denham soils were previously mapped as Blackearth associates of the Altona, clay substrate, Association in the Winnipeg-Morris (1953) soil report.

Edenburg Series (EBG)

The Edenburg series is an Orthic Black soil developed on moderately well drained, moderately to strongly calcareous, shallow (less than 90 cm), fine loamy (CL, SiCL) sediments abruptly grading to sandy (LFS, FS) lacustrine sediments. These soils occur below the Escarpment on level to very gently sloping topography in association with Newton Siding soils. Surface runoff is slow. Permeability is moderate in the loamy sediments, and rapid in the sandy subsoil. These soils can have a high water table at approximately one metre depth for short periods in the spring.

The Edenburg soil profile has a very dark gray to black Ap and Ah horizon, 25 to 35 cm thick; a very dark grayish brown Bm horizon, 25 to 35 cm thick, and a thin, 5 to 10 cm thick transition BC horizon grading into a Ck horizon. A Cca horizon often occurs above the contact with the sandy sediments. This soil profile differs from the very similar Eigenhof series in having slightly coarser textures in the subsoil. The Edenburg soils were previously mapped as the Altona (heavy) sandy substrate in the Morris Map Sheet Report No. 5, 1953.

Edkins Series (EDK)

The Edkins series consists of poorly drained Rego Humic Gleysol soil developed on a thin mantle (40 to 60 cm) of moderately to strongly calcareous, shallow loamy (L,SiL,SiCL,L,CL), lacustrine deposits over moderately to strongly calcareous, clayey (C,SiC) lacustrine deposits. These soils occur in level to depressional positions on nearly level landscapes and have restricted permeability, slow surface runoff, and a high water table during the growing season. Edkins soils are noneroded, nonstony, and frequently slightly saline. They have a high available water holding capacity, high organic matter content, and low natural fertility. Native vegetation includes sedges, rushes, willows and reeds. The majority of these soils are currently under native vegetation.

In a representative profile of Edkins soil the solum is approximately 25 cm thick. The profile is characterized by very dark gray, calcareous Ah horizon, 15 to 30 cm thick, a light gray AC horizon, 8 to 20 cm thick, usually a Cca horizon, 5 to 10 cm

thick with lime accumulation and a calcareous C horizon, with mottles and gypsum crystals.

Edkins soils occur in close association with Denham, Graysville and Rignold soils. They are similar to Blumenfeld soils by having a poorly drained profile and loamy surface mantle but differ from them in having a clayey substrate rather than a fine loamy substrate. Edkins soils were previously mapped as Meadow associates of the Altona, clay substrate, Association in the Winnipeg-Morris (1953) soil report.

Eigenhof Series (EGF)

The Eigenhof series consists of moderately well to well drained Orthic Black soil developed on moderately to strongly calcareous, deep, stratified, fine loamy (CL,SiCL,CL), lacustrine deposits. These soils occur in upper positions of nearly level to very gently slopes on undulating landscapes and have moderate to moderately slow permeability, moderate surface runoff, and a low water table during the growing season. Eigenhof soils are noneroded, nonstony and nonsaline. They have a medium available water holding capacity, medium organic matter content, and high natural fertility. Native vegetation includes aspen-oak groves, shrubs and prairie grasses. The majority of these soils are currently cultivated for grain crop production.

In a representative profile of Eigenhof soil the solum is approximately 40 cm thick. The profile is characterized by a very dark gray to black Ah horizon, 15 to 25 cm thick, a grayish brown Bm horizon, 15 to 20 cm thick, a weakly calcareous, transitional BC horizon 5 to 15 cm thick, and a moderately calcareous C horizon, with stratified SiL and SiCL textures. A typical profile also contains thin layers of fine sand to silt below the solum.

Eigenhof soils occur in close association with Neuhorst soils. They are similar to Denham soils by having an Orthic Black profile but differ from them in having no clayey substrate diagnostic of Denham soils. Eigenhof soils were previously mapped as well drained, Blackearth associates of the Altona, heavy, Association in the Winnipeg-Morris soil report (1953).

Gnadenthal Series (GDH)

The Gnadenthal series consists of imperfectly drained Gleyed Rego Black soil developed on moderately to strongly calcareous, deep stratified, loamy (VFSL,L,SiL), fluvial and lacustrine deposits. These soils occur in middle positions of nearly level to very gentle slopes on undulating landscapes and have moderate permeability, moderately slow surface runoff, and a medium water table during the growing season. Gnadenthal soils are noneroded, nonstony, and frequently slightly saline. They have a medium available water holding capacity, medium organic matter content, and high natural fertility. Native vegetation includes tall prairie grasses and aspen-oak groves. The majority of these soils are currently cultivated for grain crop production.

In a representative profile of Gnadenthal soil the solum is approximately 30 cm thick. The profile is characterized by a very dark gray to black weakly calcareous Ap horizon, 15 to 40 cm thick, a gray to dark gray AC horizon, 7 to 25 cm thick with moderate calcareousness, occasionally a Cca horizon, 5 to 10 cm thick with lime accumulation and a C horizon with iron mottles. The parent material is typically stratified with FSL,SiCL and CL textures.

Gnadenthal soils occur in close association with Reinfeld and Blumenfeld soils. They are similar to Neuenberg soils by having a Gleyed Rego Black profile and loamy surface but differ from them in having a finer textured subsoil. Gnadenthal soils were previously mapped as Black Meadow associates of the Altona Association in the Winnipeg-Morris (1953) soil report.

Glenmoor (GOO)

The Glenmoor series consists of poorly drained Rego Humic Gleysol soil developed on a thin mantle (< 1 m) of moderately to strongly calcareous, clayey lacustrine deposits over very strongly to extremely calcareous, silty, lacustrine deposits. An underlay of lacustrine clay generally occurs at or below 1m. These soils occur in low to depressional positions of level to very gentle slopes on nearly level landscapes and have slow to moderate permeability, very slow surface runoff and a high water table during the growing season. Glenmoor soils are noneroded, nonstony and may be saline. They have medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes sedges, grasses and willow. The majority of these soils are currently used for cultivation providing adequate drainage is maintained.

In a representative profile of the Glenmoor soil the solum is approximately 10 to 25 cm thick. The profile is characterized by a thin, very dark gray, clay Ah(Ap) horizon, 0 to 22 cm, with a moderately

calcareous, olive gray, clay Ckg horizon, 22 to 45 cm and a pale olive to olive, very strongly to extremely calcareous, SiL-SiCL, mottled, 2Ckg horizon. The parent material is typically clayey over silty. A typical profile also contains a clayey substrate below the silty sediments at or below 1 m.

Glenmoor soils occur in close association with Dencross soils. They are similar to Dencross soils by having similar materials but differ because of poorer drainage. Glenmoor soils were previously mapped as part of the Fort Garry association in the Winnipeg Map Sheet (Report No. 5, 1953).

Gretna Series (GRA)

The Gretna series is characterized by a Gleyed Solonetzic Black intergrading to a Gleyed Black Solonetz solum, with imperfect soil drainage, and developed on weakly to moderately calcareous, fine to very fine clayey, fluvial and lacustrine sediments. They occur below the escarpment in areas that were affected by the backbeach deposits of Lake Agassiz and subsequent flooding and deposition of fine textured sediments derived from the Cretaceous shales and the associated till. The clayey strata vary in thickness from 1 to 4 m and may be underlain by stratified silty sediments. These soils occur on level to depressional areas with soluble salts that contain a considerable proportion of sodium ion. Surface runoff is moderately slow and permeability is very slow, particularly in the B horizon with high sodium.

The solum has a very dark gray to black Ah horizon 10 to 15 cm thick with clay that is very sticky when wet, forms hard clods when dry and is neutral to mildly alkaline in reaction; a massive very dark gray to black Bnjgj horizon, 12 to 20 cm thick with heavy clay texture; and a transitional BC horizon 5 to 15 cm thick. The massive B horizon breaks as weak subangular blocky fragments that have curved or conchoidal edges when moist; it forms hard irregular blocks or clods when dry which are difficult to break. Under pasture conditions, a shallow columnar Bnjgj1, 10 to 12 cm thick is common and grades into the massive Bnjgj2; the Ah is commonly 5 cm thick. Under cultivation, this columnar structure is broken up and incorporated with the Ap. Gypsum crystals are commonly noted within and below the BC horizon. The gray to olive gray Ckgj horizon is calcareous, usually gypsiferous and has a variable amount of other salts.

The Gretna series occurs in association with the Blumengart and Deadhorse series. It was previously mapped as the imperfectly drained, slightly alkalized Blackearth member of the Gretna Association in the South-Central (1943) report.

Graysville Series (GYV)

The Graysville series consists of imperfectly drained Gleyed Rego Black soil developed on a mantle (60 to 90 cm) of moderately to strongly calcareous, loamy (VFSL,L,SiL,SiCL, CL), fluvial and lacustrine deposits over moderately calcareous, clayey (C,SIC), lacustrine deposits. These soils occur in middle positions of nearly level slopes on undulating landscapes; surface runoff is slow. Permeability is moderate in the loamy overlay and very slow in the clayey substrate. They have a perched water table during the spring and early growing season. Graysville soils are noneroded, nonstony, and occasionally slightly saline. They have a high available water holding capacity, high organic matter content, and high natural fertility. Native vegetation includes prairie grasses and willows. The majority of these soils are currently cultivated for grain crop production.

The solum is approximately 30 cm thick with a very dark gray Ah horizon, 15 to 40 cm thick; and an AC horizon, 8 to 20 cm thick with moderate calcareousness. The IICk clay horizon, has many distinct mottles and contains gypsum; a Cca horizon, 5 to 8 cm thick may be present.

Graysville soils occur in close association with Denham, Rignold and Edkins soils. Graysville soils were previously mapped as Black Meadow associates of the Altona, heavy substrate in the Winnipeg-Morris (1953) soil report.

Hoddinott Series (HDN)

The Hoddinott series consists of imperfectly drained Gleyed Black soils developed on a thin clayey strata over a very strongly to extremely calcareous silty lacustrine strata, which generally vary in thickness from 20 to 75 cm and in turn overlies calcareous clay. The surface texture may vary from clay loam to clay. The topography is level to very gently sloping; runoff is slow; and permeability is moderately slow in the upper clay strata, and variable from moderately rapid to slow in the silty strata due to the variability of the silt content, stratification and thickness. Permeability of the underlying clay is slow. Native vegetation consisted of tall prairie grasses and dispersed clumps of aspen and willow. The majority of these soils are cultivated for grain crop production.

The soil is characterized by a dark granular Ah horizon 12 to 20 cm thick and a dark grayish brown Bmgj horizon 10 to 18 cm thick. The structure is medium prismatic to fine granular. The solum is developed in the upper clay strata usually terminating abruptly at the extremely calcareous silty strata, although some tonguing of the clay into the silty strata may be noted.

Hoddinott soils occur in close association with Dencross and Glenmoor soils. They were previously mapped as the Blackearth-Meadow associate of the Emerson (heavy) association in the Winnipeg-Morris Report No. 5, 1953.

Hochfeld Series (HHF)

The Hochfeld series consists of moderately well drained Orthic Black soil developed on moderately calcareous, coarse loamy (VFS,LVFS,FSL,SL), lacustrine deposits. These deposits range in thickness from 1.5 to 5 meters over finer textured lacustrine sediments. These soils occur in upper positions of very gentle slopes on undulating landscapes and have moderately rapid permeability, moderate surface runoff, and a low water table during the growing season. Hochfeld soils are often slightly eroded, and are usually nonstony and nonsaline. They have a medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation includes aspen oak, shrubs and prairie grasses. The majority of these soils are currently cultivated for grain crop production.

In a representative profile of Hochfeld soil the solum is approximately 50 cm thick. The profile is characterized by a dark gray to very dark gray Ah horizon, 15 to 25 cm thick, a brown Bm horizon, 15 to 40 cm thick, usually a light brown Cca horizon, 5 to 8 cm thick, and a brown Ck horizon, with many faint mottles.

Hochfeld soils occur in close association with Reinland soils. These soils were previously mapped as Blackearth associates of the Altona (light) Association in the Winnipeg-Morris (1953) soil report.

Hibsin Series (HIN)

The Hibsin series consists of moderately well drained Orthic Black soil developed on a mantle (40 to 90 cm) of weakly to moderately calcareous, shallow, coarse loamy to sandy (LVFS,VFS,FSL,FS,LFS), lacustrine deposits over moderately calcareous, uniform, deep, clayey (SiC,C), lacustrine deposits. These soils occur in upper positions of very gentle slopes on undulating landscapes and have moderately rapid over slow permeability, moderate surface runoff, and a low water table during the growing season. Hibsin soils are noneroded, nonstony, and nonsaline. They have a medium available water holding capacity, high organic matter content, and medium natural fertility. Native vegetation includes aspen, oak, shrubs and prairie grasses. The majority of these soils are currently cultivated for grain crop production.

In a representative profile of Hibsin soil the solum is approximately 40 cm thick. The profile is characterized by a very dark gray to dark gray Ah horizon, 15 to 25 cm thick; a brown Bm horizon, 20 to 30 cm thick; a Cca horizon, 8 to 13 cm thick with lime accumulation and a Ck horizon. The profile is usually developed entirely in the coarser material.

Hibsin soils occur in close association with Rosebank soils. They are similar to Hochfeld soils by having an Orthic Black profile in coarse loamy deposits but differ from them in having a clayey substrate. Hibsin soils were previously mapped as associates of the Altona (light) Association in the Winnipeg- Morris (1953) soil report.

Horndean Series (HND)

The Horndean series is a Gleyed Black soil developed on imperfectly drained, moderately to strongly calcareous, clayey (SiC, C) sediments overlying sandy to loamy stratified fluvial and lacustrine sediments, that range in texture from fine sand to silty clay loam. These soils occur in the western section of the Red River Plain on level to very gently sloping terrain in association with Dugas and Jordan soils. Surface runoff is slow. Permeability is moderately slow to slow in the clayey sediments and moderate in the underlying sandy to loamy sediments; downward movement of water can be restricted during the spring by a high water table. Horndean soils are noneroded, nonstony and often slightly saline. They have high available water holding capacity and organic matter and medium natural fertility. Native vegetation includes tall prairie grasses associated with occasional clumps of aspen and willow. The majority of these soils are cultivated for grain crop production.

The Horndean soil profile has a granular structured, black to very dark gray Ah horizon, 20 to 30 cm thick, that is plastic and sticky when wet, very firm when moist and very hard when dry; a very dark brown to very dark grayish brown Bm horizon,

15 to 25 cm thick, having blocky structure, plastic and sticky consistence when wet, and a thin transitional BC horizon. This transitional horizon grades to a grayish brown Cgj horizon that is granular structured, firm when moist, distinctly mottled and gypsiferous, particularly near the contact of the clayey and sandy materials. The underlying sediments are stratified, usually saline and mottled.

This soil differ only slightly from the Dugas series in having a Bmgj horizon. The clayey Plum Coulee soils, like Horndean soils are imperfectly drained Gleyed Blacks, but are more uniformly fine textured in the subsoils.

Jordan Series (JOD)

The Jordan series is an Orthic Black soil developed on moderately well drained, thin (0.6 to 1 metre), veneer of moderately to strongly calcareous, clayey sediments abruptly grading to calcareous stratified sandy (FS, LFS, LS) to loamy (VFSL, L, SiL, VFS, LVFS) lacustrine sediments. The soils occur in the western section of the Red River Plain on level to very gently sloping terrain in association with Horndean and Dugas soil series. Surface runoff is moderately slow to slow. Permeability of the clayey sediments is moderately slow to very slow, whereas subsoil permeability is moderate to moderately rapid.

The Jordan soil profile has a very dark gray to black Ah horizon, 15 to 35 cm thick, and a dark grayish brown Bm horizon, 20 to 30 cm thick with subangular blocky structure. The B horizon commonly extends to the contact of the coarser sediments. The strongly contrasting IICk horizon is variable in texture, and also has numerous, faint iron mottles.

This soil differs from the similar Winkler series in having somewhat coarser textures in its stratified subsoil. The Jordan soil was mapped as part of the Horndean Complex in the Winnipeg-Morris (1953) soil report.

Jasset Series (JST)

The Jasset series consists of imperfectly drained Gleyed Black soil developed on a mantle (70 to 90 cm) of moderately to strongly calcareous, shallow loamy (VFSL,L,SiL), lacustrine deposits over moderately calcareous, stratified, deep, sandy (FS,LFS,VFS) lacustrine deposits. These soils occur in middle positions of very gentle slopes on undulating landscapes and have moderate over moderately rapid permeability, slow surface runoff, and a high water table during the growing season. Jasset soils are noneroded, nonstony, and occasionally slightly saline. They have medium available water holding capacity, high organic matter content, and medium natural fertility. Native vegetation includes aspen, oak, maple and prairie grasses. The majority of these soils are currently cultivated for grain crop production.

In a representative profile of a Jasset soil the solum is approximately 60 cm thick. The profile is characterized by a very dark gray to black Ap horizon, 25 to 35 cm thick, a brown to yellowish brown Bm horizon, 25 to 40 cm thick with fine, faint mottles, a carbonated BC horizon, 10 to 15 cm thick and a Cca horizon, 5 to 10 cm thick. A typical profile also contains a calcareous C horizon with prominent mottles.

Jasset soils occur in close association with Neuenberg and Rosengart soils. They are similar to Neuenberg soils by having an imperfectly drained profile in loamy over sandy deposits, but differ from them in having a prominent Bm horizon. Jasset soils were previously mapped as Black Meadow associates of the Altona (light) Association in the Winnipeg-Morris (1953) soil report.

Kronstal Series (KOT)

The Kronstal series consists of an imperfectly drained Gleyed Black soil developed on moderately calcareous, deep, stratified, coarse loamy (VFS,LVFS,FSL,SL), lacustrine deposits. These soils occur in middle positions of nearly level slopes on undulating landscapes and have moderate to moderately rapid permeability, moderately slow surface runoff, and a high water table during the growing season. Kronstal soils are noneroded, nonstony, and occasionally slightly saline. They have a medium available water holding capacity, high organic matter content, and medium natural fertility. Native vegetation includes aspen-oak groves, shrubs, and meadow and tall prairie grasses. The majority of these soils are currently cultivated for grain crop production.

In a representative profile of a Kronstal soil the solum is approximately 55 cm thick. The profile is characterized by a very dark gray Ah horizon, 20 to 30 cm thick, a grayish brown to brown Bm horizon, 20 to 40 cm thick with fine to medium yellowish mottles, a Cca horizon, 8 to 13 cm thick and a C horizon, with distinct mottles. The parent material is typically stratified with layers of FS to LFS tex-

ture.

Kronstal soils occur in close association with Hochfeld, Reinland and Osterwick soils. They are similar to Jasset soils by having a Gleyed Black profile and coarse loamy substrate but differ from them in having no loamy surface mantle. Kronstal soils were previously mapped as Black Meadow associates of the Altona Association in the Winnipeg-Morris (1953) soil report.

Loewen Series (LEW)

The Loewen series consists of poorly drained Rego Humic Gleysol soil developed on none to weakly calcareous, stratified, loamy (CL,L,SiCL,SCL) fluvial deposits.

These soils occur in depressional positions of gentle slopes often along stream channels on flood prone landscapes and have restricted permeability, very slow surface runoff, and a high or ponded water table during the growing season. Loewen soils are noneroded, nonstony, and frequently slightly saline. They have a medium available water holding capacity, medium organic matter content, and low natural fertility. Native vegetation includes sedges, reeds, rushes and willows. The majority of these soils are currently in native vegetation.

In a representative profile of Loewen soil there is little or no solum development. The profile is characterized by a mixed peaty-mineral surface horizon, 10 to 15 cm thick, a thin, carbonated Ah horizon, 5 to 15 cm thick, and a olive gray Ckg horizon, with variable textures. A typical profile also contains buried surface layers at various depth.

Loewen soils occur in close association with Chortitz soils. They are similar to Blumenort soils by having a poorly drained profile developed in alluvium but differ from them in having dominantly loamy textures. Loewen soils were previously mapped as associates of the Riverdale Complex in the Winnipeg-Morris (1953) soil report.

Lakeland Series (LKD)

The Lakeland series consists of imperfectly drained Gleyed Rego Black carbonated soils developed on moderately to extremely calcareous, dominantly fine loamy sediments. Surface textures range from loam to clay loam and occasionally silty clay. The topography is level to very gently sloping; runoff is slow; and permeability is moderate to moderately slow. The native vegetation consists of meadow grasses with clumps of willow. In some areas, there is an upward flow of groundwater containing soluble salts. Where the salt content in the rooting zone is sufficient to affect crop growth, the Lakeland slightly saline phase is mapped.

Lakeland soils like most soils developed on extremely calcareous parent material have shallow soil profiles. The thin 15-25 cm very dark gray Ah horizon is granular, and usually moderately to strongly calcareous. This horizon is usually separated from the pale yellow, extremely calcareous Ckgj horizon by a thin (15-20 cm) transitional, AC or Cca layer that is usually very strongly calcareous.

Lakeland, slightly saline phase consists of soils with similar profile characteristics as the Lakeland series, except they have a appreciable quantity of soluble salts within the rooting zone of plants in sufficient quantity to affect crop growth. The salts are dominantly magnesium sulfate and gypsum.

These soils were formerly mapped as the imperfectly drained Calcareous Blackearth-Meadow associates of the Emerson (silty clay loam) Association in the Winnipeg-Morris (1953) report.

Morris Series (MRS)

The Morris series consists of imperfectly drained Gleyed Solonetzic Black soils developed on moderately to strongly calcareous fine textured lacustrine deposits. They occur on level to very gently sloping topography usually adjacent to or intermediate between poorly drained Osborne clay soils and the imperfectly drained Red River or Scanterbury clay soils. Runoff is moderately slow to slow; permeability is very slow and restricted by the columnar and fine subangular blocky to massive, high swelling B horizons.

In the virgin state, these soils are characterized by a shallow dark gray to gray Ah or Ahej horizon 5 to 8 cm thick, a dark gray to gray columnar Bnjgj1 horizon 10 to 15 cm thick and an amorphous dark gray to black, waxy Bnjgj2 horizon that breaks into coarse subangular blocky peds. Gypsum may be present in the olive gray to grayish brown weakly mottled Ckgj horizon. Under cultivation, most of the columnar Bnjgj1 horizon is incorporated with the Ap horizon. In the moist condition, the Ap is sticky and massive and breaks under pressure into weak, medium to fine granular peds; in the dry condition, the Ap is cloddy and hard, and breaks with difficulty into coarse clods or rounded blocks.

The Morris soils occur in close association with the Red River, Scanterbury and Osborne soils. They were previously mapped as the alkalinized associate of the Red River Association in the Winnipeg-Morris (1953) soil report.

Myrtle Series (MYT)

The Myrtle series consists of well to moderately well drained Orthic Black soils developed on moderately to strongly calcareous clayey lacustrine deposits. The surface texture ranges from silty clay to clay. The topography is very gently to gently sloping; runoff is moderate; and permeability is moderate in the solum due to granular structure, but moderately slow to slow at greater depths.

The Myrtle soil is characterized by a deep, dark gray Ah horizon 30 to 45 cm thick, with friable fine granular structure, a dark brown to dark grayish brown Bm horizon, 25 to 40 cm thick, with moderate medium prismatic breaking to medium granular structure. The C horizon is light brownish gray to pale brown and has a pseudosubangular blocky structure.

The Myrtle soil is differentiated from the Scanterbury soil by a deeper, friable Ah horizon, brighter chroma in the B horizon and lack of any mottles in the B or upper part of the C horizon. The chemical and physical analyses of the Myrtle soil is similar to the Scanterbury series. The Myrtle soils are representative of the well drained associate of the Myrtle association as mapped in the South Central (1943) soil report.

Neuenberg Series (NBG)

The Neuenberg series consists of imperfectly drained Gleyed Rego Black soil developed on a mantle (70 to 90 cm) of moderately to strongly calcareous, shallow, loamy (VFSL,L,SiL), fluvial and lacustrine deposits over moderately calcareous, stratified, deep, coarser (LFS,FS,VFS,LVFS), lacustrine deposits. These soils occur in middle positions of nearly level to very gentle slopes on very gently undulating landscapes and have moderate over rapid permeability, moderate to moderately slow surface runoff, and a high water table during the growing season. Neuenberg soils are noneroded, nonstony, and often slightly saline. They have a medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation includes aspen, oak, shrubs and prairie grasses. The majority of these soils are currently cultivated for crop production.

In a representative profile of a Neuenberg soil the solum is approximately 50 cm thick. The profile is characterized by a very dark gray Ah horizon, 15 to 25 cm thick, with moderate calcareousness, an AC horizon, 10 to 20 cm thick, frequently a Cca horizon, 5 to 8 cm thick, and a Ckgj horizon, with many distinct mottles. A typical profile contains VFSL,L textures grading to VFS and FS with depth.

Neuenberg soils occur in close association with Rosengart and Jasset soils. They are similar to Gnadenthal soils by having a Gleyed Rego Black profile and loamy surface mantle but differ from them in having coarser textures rather than finer textures at depth. Neuenberg soils were previously mapped as Black Meadow associates of the Altona (light) Association in the Winnipeg- Morris (1953) soil report.

Neuhorst Series (NUH)

The Neuhorst series consists of imperfectly drained Gleyed Rego Black soil developed on moderately calcareous, deep, uniform, fine loamy (SCL,CL,SiCL), fluvial and lacustrine deposits. These soils occur in middle positions of nearly level to very gentle slopes on very gently undulating landscapes and have moderately slow to slow permeability, slow surface runoff, and a medium water table during the growing season. Neuhorst soils are noneroded, nonstony, and occasionally slightly saline. They have a medium available water holding capacity, medium organic matter content, and high natural fertility. Native vegetation includes tall prairie grasses, prairie-meadow grasses and shrubs. The majority of these soils are currently cultivated for grain crop production.

In a representative profile of Neuhorst soil the solum is approximately 30 cm thick. The profile is characterized by a very dark gray Ah horizon, 25 to 40 cm thick, with weak calcareousness, a dark gray to gray AC horizon, 8 to 20 cm thick, frequently a light gray Cca horizon, 10 to 15 cm thick with lime accumulation and a light gray to pale yellow C horizon, with many distinct mottles. A typical profile also contains gypsum crystals below the AC or Cca horizon.

Neuhorst soils occur in close association with Eigenhof soils. They are similar to Newton Siding soils by having Gleyed Rego Black profile and fine loamy surface but differ from them in not having a sandy substrate. Neuhorst soils were previously mapped as Black Meadow associates of the Altona Association in the Winnipeg-Morris (1953) soil

report.

Newton Siding Series (NWN)

The Newton Siding series consists of imperfectly drained Gleyed Rego Black soil developed on a mantle (40 to 90 cm) of moderately to strongly calcareous, shallow fine loamy (SCL,CL,SiCL), fluvial and lacustrine deposits over moderately calcareous, stratified, deep, sandy (LFS,FS), fluvial and lacustrine deposits. These soils occur in middle positions of nearly level slopes on undulating landscapes and have moderately slow over moderately rapid permeability, slow surface runoff, and a high water table during the growing season. Newton Siding soils are noneroded, nonstony, and occasionally slightly saline. They have a medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation includes prairie-meadow grasses, shrubs and tall-prairie grasses. The majority of these soils are currently cultivated for crop production.

In a representative profile of Newton Siding soil the solum is approximately 30 cm thick. The profile is characterized by a very dark gray Ah horizon, 25 to 40 cm thick, with weak calcareousness, a gray AC horizon, 8 to 20 cm thick with moderate calcareousness, a Ccagj horizon, 10 to 15 cm thick is often present, overlying and a IICkgj horizon, with prominent mottles.

Newton Siding soils occur in close association with Edenberg soils. They are similar to Neuhorst soils by having an imperfectly drained profile developed in fine loamy deposits but differ from them in having a sandy substrate. Newton Siding soils were previously mapped as inclusions of the Altona Association in the Winnipeg-Morris (1953) soil report.

Osborne Series (OBO)

The Osborne series consists of poorly drained Rego Humic Gleysol soils developed on moderately to strongly calcareous, deep uniform, clayey, lacustrine deposits. These soils occur in lower to depressional positions of level to nearly level slopes on level landscapes and have very slow permeability, slow to very slow surface runoff and a high water table during the growing season. Osborne soils are noneroded, nonstony and may be saline. They have high available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes meadow grasses, reeds, sedges and willow. The majority of these soils have improved drainage and are currently used for crop production.

In a representative profile of Osborne soil the solum is approximately 30 cm thick. The profile is characterized by a very dark gray, noncalcareous, clay, Ap horizon, 15 to 20 cm thick, with a thin transitional, dark gray to olive gray weakly calcareous AC horizon, 8 to 10 cm thick and an olive gray, moderately to strongly calcareous, clayey, mottled Ckg horizon. The parent material is typically a uniform clayey lacustrine deposit.

Osborne soils occur in close association with Red River, Morris and Scanterbury soils. They are similar to these soils by having developed on the same parent material but differ because of poorer drainage. Osborne soils were previously mapped as Osborne clay in the Winnipeg-Morris Map Sheet (Report No. 5, 1953).

Osterwick Series (OWK)

The Osterwick series is a Rego Humic Gleysol soil developed on poorly drained, moderately to strongly calcareous, coarse loamy (VFS, LVFS, FSL, VFSL, L), lacustrine and fluvial sediments. These soils occur on depressional topography in association with Reinland and Kronstal soils. Surface runoff is very slow. Permeability is moderately rapid, but is restricted by a seasonal high water table. Improved surface drainage has occurred, but some areas have not been adequately improved and surface ponding is common. Some forage crops are grown but a few areas remain as pasture or wetland.

The Osterwick soil profile has a thin, moderately decomposed organic, Om horizon, 6 to 12 cm thick; a very dark gray Ah horizon, 15 to 25 cm thick; a light gray transitional AC horizon, 5 to 20 cm thick, and a gray Ckg horizon with yellowish brown mottles. A lime carbonate accumulation layer (Cca horizon), 20 to 25 cm thick, is commonly found below the AC horizon. This soil differs from the somewhat similar Lelant series in having coarse loamy sediments, while Lelant soils are dominantly sandy.

Osterwick soils have limitations for agriculture due to excess water in the soil profile for much of the growing season. These soils were mapped as the poorly drained, Meadow associate of the Altona Association in the Winnipeg- Morris (1953) report.

Plum Coulee Series (PME)

The Plum Coulee series is a Gleyed Black soil

developed on imperfectly drained, moderately calcareous, stratified, clayey (SiC, C), fluvial and lacustrine sediments. These soils occur in the western part of the Red River Plain on level to very gently sloping topography, in association with Winkler and Deadhorse soils. Surface runoff is moderately slow, and permeability is slow. Most of these soils are cleared and under cultivation. Native vegetation consists of tall prairie and prairie-meadow grasses. The majority of Plum Coulee soils are cultivated for production of annual grain crops.

The Plum Coulee soil profile has a firm to friable, very dark Ah horizon, 13 to 25 cm thick; a dark gray to dark grayish brown Bmgj horizon, 15 to 30 cm thick with compound weak, medium prismatic and moderate, medium granular structure. Faint mottles are apparent in the lower B horizon and are more noticeable with increasing depth. The mottled Ckgj horizon is usually stratified (C,SiC,SiCL) with dominantly clay textures. Gypsum crystals also occur in the Ckgj horizon. This soil differs from the very similar Deadhorse soil in having a prominent Bmgj horizon.

Plum Coulee soils occur in association with the Winkler and Deadhorse series. They were mapped as the Blackearth-Meadow associate of the Horndean Complex in the Winnipeg-Morris (1953) report.

Rosebank Series (RBK)

The Rosebank series is a carbonated, Gleyed Rego Black soil developed on imperfectly drained, moderately calcareous, thin (25 to 100 cm), coarse loamy (LVFS, VFS, FSL), sediments overlying moderately calcareous, clayey (SiC, C), lacustrine sediments. The coarse loamy sediments are usually stratified and include strata of coarser or finer textures. These soils occur on level to very gently sloping topography in association with Hibsin and Elm Creek soils. Surface runoff is slow. Permeability is moderate in the coarse loamy sediments and slow to very slow in the underlying clayey sediments.

The Rosebank soil profile has a very dark gray to black, very friable, weakly granular Ah horizon, 15 to 30 cm thick that is often weakly calcareous and mildly alkaline in reaction, and a dark gray to grayish brown AC horizon that is granular, very friable to loose, calcareous and mildly alkaline. The Ckgj horizon is pale brown, very friable to loose, mildly alkaline and faintly mottled. Calcium carbonate concretions and many, fine to medium mottles often occur at the clay contact.

Rosebank soils have a finer textured and less permeable subsoil than the very similar coarse loamy Reinland soils. They are coarser textured in their surface layers and finer textured in their subsurface layers than the very similar, uniformly loamy textured Gnadenthal and Neuenberg soils. Both the Rosebank and the very similar Graysville soils have clayey textured subsurface layers; however, Graysville soils with their finer textured surface layers are less droughty and less permeable than Rosebank soils.

Rosebank soils have a moderate agricultural limitation because of a frequent moisture deficit during the growing season. These soils are also somewhat susceptible to wind erosion and must be carefully managed to maintain as much crop residue as possible at all times.

Reinfeld Series (RFD)

The Reinfeld series consists of moderately well to well drained Orthic Black soil developed on moderately to strongly calcareous, stratified, deep, loamy (VFSL,L,SiL) grading to fine loamy (SCL,CL,SiCL), fluvial and lacustrine deposits. These soils occur in upper positions of very gentle slopes on undulating landscapes and have moderate permeability, moderate surface runoff, and a low water table during the growing season. Reinfeld soils are noneroded, nonstony, and nonsaline. They have a medium available water holding capacity, medium organic matter content, and high natural fertility. Native vegetation includes tall prairie grasses. The majority of these soils are currently cultivated for grain crop production.

In a representative profile of Reinfeld soil the solum is approximately 50 cm thick. The profile is characterized by a very dark gray Ah horizon, 15 to 40 cm thick, a brown Bm horizon, 15 to 25 cm thick, and a pale brown Ck horizon, with occasional faint mottles.

Reinfeld soils occur in close association with Gnadenthal and Blumenfeld soils. They are similar to Rosengart soils by having a well drained Black profile and a loamy surface but differ from them in not having a coarse substrate. Reinfeld soils were previously mapped as Blackearth associates of the Altona Association in the Winnipeg-Morris (1953) soil report.

Rignold Series (RGD)

The Rignold series consists of imperfectly

drained Gleyed Black soil developed on a mantle (60 to 90 cm) of moderately calcareous, shallow, uniform, loamy (VFSL,L,SiL,SCL,CL,SiCL), fluvial and lacustrine deposits over moderately calcareous, deep, uniform, clayey (SiC,C), lacustrine deposits. These soils occur in middle positions of nearly level slopes on level landscapes and have moderate over slow to very slow permeability, slow surface runoff, and a high water table during the growing season. Rignold soils are noneroded, nonstony, and occasionally slightly saline. They have a medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation includes tall prairie grasses, meadow grasses and shrubs. The majority of these soils are currently cultivated for grain crop production.

In a representative profile of Rignold soil the solum is approximately 50 cm thick. The profile is characterized by a very dark gray Ah horizon, 18 to 25 cm thick, a light brown Bm horizon, 20 to 30 cm thick, a transitional BC horizon, 10 to 15 cm thick with faint mottles and a light olive brown Ckgj horizon with fine yellowish brown mottles.

Rignold soils occur in close association with Denham, Graysville and Edkins soils. They are similar to Graysville soils by having imperfectly drainage and loamy over clayey deposits but differ from them in having a prominent Bm horizon. Rignold soils were previously mapped as Black Meadow associates of the Altona (clay sub.) Association in the Winnipeg-Morris (1953) soil report.

Red River Series (RIV)

The Red River series consists of imperfectly drained Gleyed Rego Black soils developed on moderately to strongly calcareous, deep, uniform, clayey, lacustrine deposits. These soils occur in level to upper positions of level to very gentle slopes on level landscapes and have slow permeability, slow to moderate surface runoff and a medium water table during the growing season. Red River soils are noneroded, nonstony and may have slight to moderate subsoil salinity. They have medium to high available water holding capacity, medium organic matter content, and medium natural fertility. The majority of these soils are currently used for crop production.

In a representative profile of Red River soil the solum is approximately 30 cm thick. The profile is characterized by a black, to very dark gray clayey Ap horizon, 15 to 20 cm thick, a very dark gray, clayey Ah horizon, 8 to 10 cm thick which frequently tongues well into the C horizon, a thin, dark gray, calcareous, clay, ACkgj horizon, 6 to 10 cm thick and a dark grayish brown, calcareous, clay Ckgj horizon with faint mottles. The parent material is typically a uniform clay.

Red River soils occur in very close association with Scanterbury, Morris and Osborne soils. They are similar to the above soils by having developed on the same parent material but differ because of drainage and profile development. Red River soils were previously mapped as the imperfectly drained associate of the Red River Association in the Winnipeg-Morris Map Sheet, Report No. 5, 1953.

Reinland Series (RLD)

The Reinland series consists of imperfectly drained Gleyed Rego Black soil developed on moderately to strongly calcareous, stratified, deep, coarse loamy (LVFS,VFS,FSL,SL), fluvial and lacustrine deposits. These soils occur in middle positions of very gentle slopes on undulating landscapes and have moderate to moderately rapid permeability, moderate surface runoff, and a high water table during the growing season. Reinland soils are noneroded, nonstony, and occasionally slightly saline. They have a medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation includes prairie grasses interspersed with occasional bluffs of deciduous trees. The majority of these soils are currently cultivated for grain crop production.

In a representative profile of Reinland soil the solum is approximately 25 cm thick. The profile is characterized by very dark gray Ah horizon, 15 to 30 cm thick, with weak calcareousness, a dark gray to grayish brown AC horizon, 8 to 20 cm thick, a light gray Cca horizon, 8 to 10 cm thick and a pale brown to light gray Ckgj horizon, with faint mottles.

Reinland soils occur in close association with Hochfeld, Kronstal and Osterwick soils. They are similar to Rosebank soils by having imperfect drainage and a coarse loamy surface but differ from them in having no clayey substrate. Reinland soils were previously mapped as Blackearth-Meadow associates of the Altona Association in the Winnipeg-Morris (1953) soil report.

Rosengart Series (RSG)

The Rosengart series consists of moderately well drained Orthic Black soil developed on a mantle (70

to 95 cm) of moderately to strongly calcareous, shallow, uniform, loamy (VFSL,L,SiL), deposits over moderately calcareous, stratified, deep, sandy (LFS,FS,VFS,LVFS), lacustrine deposits. These soils occur in upper positions of very gentle slopes on undulating landscapes and have moderate over moderately rapid permeability, moderate to moderately rapid surface runoff, and a medium water table during the growing season. Rosengart soils are noneroded, nonstony, and nonsaline. They have medium available water holding capacity, medium organic matter content, and high natural fertility. Native vegetation includes tall prairie grasses, shrubs and aspen-oak groves. The majority of these soils are currently cultivated for crop production.

In a representative profile of Rosengart soil the solum is approximately 45 cm thick. The profile is characterized by a very dark gray Ah horizon, 15 to 35 cm thick, a dark grayish brown Bm horizon, 15 to 25 cm thick, a BC horizon, 10 to 18 cm thick and a pale brown Ck horizon with faint to distinct mottles.

Rosengart soils occur in close association with Jasset and Neuenberg soils. They are similar to Reinfeld soils by having an Orthic Black profile and loamy surface but differ from them in having a sandy substrate. Rosengart soils were previously mapped as Blackearth associates of the Altona Association in the Winnipeg-Morris (1953) soil report.

Rathwell Series (RWL)

The Rathwell series consists of imperfectly drained Gleyed Black soil developed on strongly calcareous, deep, uniform, fine loamy (CL,SiCL), lacustrine deposits. These soils occur in middle positions of very gentle slopes on level to undulating landscapes and have moderate to moderately slow permeability, moderate surface runoff, and a high water table during the growing season. Rathwell soils are noneroded, nonstony, and often slightly saline. They have medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation includes prairie grasses, prairie-meadow grasses, deciduous trees and shrubs. The majority of these soils are currently cultivated for grain crop production.

In a representative profile of Rathwell soil the solum is approximately 50 cm thick. The profile is characterized by a very dark gray to black Ap or Ah horizon, 20 to 30 cm thick, a brown Bm horizon, 15 to 20 cm thick with distinct mottles, a transitional BC horizon, 8 to 12 cm thick and a Ckgj horizon, with many distinct mottles.

Rathwell soils occur in close association with Eigenhof and Neuhorst soils. They are similar to Rignold soils by having imperfect drainage and loamy surface deposits but differ from them in not having a clayey substrate. Rathwell soils were previously mapped as associates of the Altona Association in the Winnipeg-Morris (1953) soil report.

Scanterbury Series (SCY)

The Scanterbury series is a Gleyed Black soil developed on imperfectly drained, moderately to strongly calcareous, clayey (SiC, C, HC), lacustrine deposits. These soils occur on level to very gently sloping topography on the Red River Plain in association with Red River, Morris and Osborne soils. Surface runoff is slow and permeability is very slow. The tall prairie and prairie-meadow grasses once found associated with these soils have been mostly replaced by cultivated fields.

The Scanterbury soil profile has a very dark gray Ah horizon, 15 to 30 cm thick that frequently tongues through the B horizon; a very dark gray to dark grayish brown Bmgj horizon, 12 to 40 cm thick; a very dark grayish brown BC, 10 to 15 cm thick, and an olive gray calcareous Ckgj horizon with many, fine, faint mottles.

This soil differs from the similar Plum Coulee soil series in having more uniform textures in the subsoil. It differs from Red River soils in having a prominent Bmgj horizon. Scanterbury, Red River and Morris soils are usually found together in such close and intricate association with each other that it is difficult to not find all three together in the same field in areas where they normally occur.

Scanterbury soils were described as part of the Red River Association in the Winnipeg-Morris (1953) soil report.

Seine River Series (SRE)

The Seine River series consists of imperfectly drained Gleyed Cumulic Regosol soils developed on moderately to strongly calcareous clayey alluvial deposits. They occur mainly on the floodplain of the Red River in intermediate positions between the river and the upper levees. They are subject to seasonal flooding during the spring runoff period; otherwise they have moderate runoff, and moderately slow to slow permeability. The native vegeta-

tion consists of Manitoba maple, elm, ash, basswood and native grasses.

The soil is characterized by a thin partially decomposed leaf mat 2 to 4 cm thick, and a variable dark gray Ah horizon 3 to 6 cm thick; the Ckgj horizon has a variable texture of silty clay to clay and may have thin former Ah horizons in the stratified layers of the subsoil. In the upper slope positions these soils may have weak development of an Ah and Bm horizon grading to the Scanterbury or Myrtle series. This soil was previously mapped as the immature alluvial soil of the Riverdale Association in the Winnipeg-Morris (1953) soil report.

Winkler Series (WIK)

The Winkler series consists of moderately well drained Orthic Black soil developed on moderately calcareous, deep, stratified, clayey (SiC,C), lacustrine deposits. These soils occur in middle positions of very gentle slopes on undulating landscapes and have moderately slow permeability, moderately slow surface runoff, and a medium water table during the growing season. Winkler soils are noneroded, nonstony, and nonsaline. They have a high available water holding capacity, high organic matter content, and medium natural fertility. Native vegetation includes tall prairie grasses, shrubs and aspen-oak groves. The majority of these soils are currently cultivated for grain crop production.

In a representative profile of Winkler soil the solum is approximately 45 cm thick. The profile is characterized by a very dark gray Ah horizon, 13 to 25 cm thick, a dark brown Bm horizon, 20 to 35 cm thick with moderate medium granular to prismatic structure, and a Ck horizon, with dominantly SiC to C textures. The parent material is typically stratified with lighter (SiL,SiCL) textures at depth.

Winkler soils occur in close association with Deadhorse and Plum Coulee soils. They are similar to Jordan soils by having an Orthic Black profile and clayey surface but differ from them by not having a sandy substrate. Winkler soils were previously mapped as Blackearth associates of the Horndean Complex in the Winnipeg-Morris (1953) soil report.

PART 4

4 USE AND MANAGEMENT INTERPRETATIONS OF SOILS

4.1 INTRODUCTION

This section provides predictions of performance or soil suitability ratings for various uses of soils based on field observations of soil and landscape characteristics, laboratory data and on observations of soil behaviour under specified conditions of land use and management. Suitability ratings or interpretations are intended only to serve as guides for planners and managers. Caution, with an understanding of the limitations of the soil map must be exercised when applying suitability ratings to soil map units. The value of any rating or interpretation depends upon the nature and composition of individual map unit delineation which in turn depends on the scale of mapping and intensity of ground truthing employed in the survey.

In this section, interpretive soil information is provided for the following land use evaluations:

1. Agriculture

   a) dryland farming capability
   b) irrigation suitability

2. Engineering Uses

3. Recreation Uses

4.2 SOIL CAPABILITY FOR AGRICULTURE

Dryland Agriculture

Soil capability classification for dryland agriculture is based on an evaluation of both internal and external soil characteristics that influence soil suitability and limitations for agricultural use. In this classification, mineral soils are grouped into capability classes, and subclasses and units based on their limitations for dryland farming, risk of damage when the soils are used and the way they respond to management (Anon, 1965). There are seven capability classes, each of which groups soils together that have the same relative degree of limitation or hazard for agricultural use. The limitation becomes progressively greater from Class 1 to Class 7. The class indicates the general suitability of the soils for agriculture. The first three classes are considered capable of sustained production of common field crops, the fourth is marginal for sustained arable agriculture, the fifth is suitable only for improved permanent pasture, the sixth is capable of use only for native pasture while the seventh class is for soils and land types considered incapable of use for arable agriculture or permanent pasture.

Soil Capability subclasses are divisions within classes which group soils with similar kinds of limita- tions and hazards for agricultural use. The various kinds of limitations recognized at the subclass level are defined in Table 5.

A summary of the soils in the study area showing their major characteristics and their interpretive classification for dryland agriculture is presented in Table 6.

4.3 CAPABILITY AND MANAGEMENT

The R.M. of Rhineland includes some of the best agricultural soils in Manitoba. The class 1 soils, which comprise approximately 38 percent of the area, include the well to imperfectly drained loamy to fine loamy soils and the well drained clayey soils. The Class 2 soils which represent about 40 percent of the municipality are generally the imperfectly drained clayey soils with a wetness limitation and a lesser area of imperfectly drained, somewhat droughty, sandy loam soils. The Class 3 capability soils consist dominantly of poorly drained soils with improved drainage and the solonetzic type clays, which together cover approximately 18 percent of the area. The soils with saline phases range from Class 3 to 4 depending upon severity and affect 5.75 percent of the municipality. The areal extent in hectares and percent coverage of the study area is summarized for the soils in the R.M of Rhineland in Table 7.

The lighter textured (SL-CL) soils, particularly in the western part of the municipality, are subject to wind erosion and require careful management of crop residues to provide sufficient trash cover. Other provisions to reduce the risk of wind erosion include shelter belts, minimum or reduced tillage and crop rotations. The clayey soils (approximately 50%) of the study generally occur on level to very gently sloping land and are subject to surface ponding and slow runoff. Therefore the mainten-

ance of adequate surface drainage becomes very important in these areas. Soil structure and tilth may also be improved through proper residue management including incorporation of stubble or green manure crops. The timing and ease of tillage on some of the very heavy clays, e.g. Gretna, Morris and Osborne Series, becomes a significant management factor. If cultivated when the soils are too moist or dry, large massive sticky lumps or very hard clods will result, forming a very poor seedbed and consequently resulting in poor germination. The optimum moisture content for tilling these heavy clay soils is critical and the timing and type of tillage is an important consideration in good management.

Definitions of the Agricultural Capability Classes

Class 1

Soils in this class have no important limitations for crop use. The soils have level or gently sloping topography; they are deep, well to imperfectly drained and have moderate water holding capacity. The soils are naturally well supplied with plant nutrients, easily maintained in good tilth and fertility; soils are moderately high to high in productivity for a wide range of cereal and special crops.

Class 2

Soils in this class have moderate limitations that reduce the choice of crops or require moderate conservation practices. The soils have good water holding capacity and are either naturally well supplied with plant nutrients or are highly responsive to inputs of fertilizer. They are moderate to high in productivity for a fairly wide range of crops. The limitations are not severe and good soil management and cropping practices can be applied without serious difficulty.

Class 3

Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. The limitations in Class 3 are more severe than those in Class 2 and conservation practices are more difficult to apply and maintain. The limitations affect the timing and ease of tillage, planting and harvesting, the choice of crops and maintenance of conservation practices. The limitations include one or more of the following: moderate climatic limitation, erosion, structure or permeability, low fertility, topography, overflow, wetness, low water holding capacity or slowness in release of water to plants, stoniness and depth of soil to consolidated bedrock. Under good management, these soils are fair to moderately high in productivity for a fairly wide range of field crops.

Class 4

Soils in this class have severe limitations that restrict the choice of crops or require special conservation practices or both. These soils have such limitations that they are only suited for a few crops, or the yield for a range of crops may be low, or the risk of crop failure is high. The limitations may seriously affect such farm practices as the timing and ease of tillage, planting and harvesting, and the application and maintenance of conservation practices. These soils are low to medium in productivity for a narrow range of crops but may have higher productivity for a specially adapted crop. The limitations include the adverse effects of one or more of the following: climate, accumulative undesirable soil characteristics, low fertility, deficiencies in the storage capacity or release of soil moisture to plants, structure or permeability, salinity, erosion, topography, overflow, wetness, stoniness, and depth of soil to consolidated bedrock.

Class 5

Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible. These soils have such serious soil, climatic or other limitations that they are not capable of use for sustained production of annual field crops. However, they may be improved by the use of farm machinery for the production of native or tame species of perennial forage plants. Feasible improvement practices include clearing of bush, cultivation, seeding, fertilizing and water control.

Some soils in Class 5 can be used for cultivated field crops provided unusually intensive management is used. Some of these soils are also adapted to special crops requiring soil conditions unlike those needed by the common crops.

Class 6

Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible. Class 6 soils have some natural sustained grazing capacity for farm animals, but have such serious soil, climatic or other limitations as to make impractical the application of improvement practices that can be carried out on Class 5 soils. Soils may be placed in this class because their physical nature prevents the use of farm machinery, or because the soils are not responsive to improvement practices, or because stock watering facilities are inadequate.

Class 7

Soils in this class have no capability for arable culture or permanent pasture because of extremely severe limitations. Bodies of water too small to delineate on the map are included in this class. These soils may or may not have a high capability for forestry, wildlife and recreation.

TABLE 5

Table 5. Agricultural Capability Subclass Limitations

C - Adverse climate: This subclass denotes a significant adverse climate for crop production as compared to the "median" climate which is defined as one with sufficiently high growing season temperatures to bring field crops to maturity, and with sufficient precipitation to permit crops to be grown each year on the same land without a serious risk of partial or total crop failures.

D - Undesirable soil structure and/or low permeability: This subclass is used for soils difficult to till, or which absorb water very slowly or in which the depth of rooting zone is restricted by conditions other than a high water table or consolidated bedrock.

E - Erosion: Subclass E includes soils where damage from erosion is a limitation to agricultural use. Damage is assessed on the loss of productivity and on the difficulties in farming land with gullies.

F - Low fertility: This subclass is made up of soils having low fertility that either is correctable with careful management in the use of fertilizers and soil amendments or is difficult to correct in a feasible way. The limitation may be due to lack of available plant nutrients, high acidity or alkalinity, low exchange capacity, high levels of carbonates or presence of toxic compounds.

I - Inundation by streams or lakes: This subclass includes soils subjected to inundation causing crop damage or restricting agricultural use.

L - Coarse wood fragments: In the rating of organic soils, woody inclusions in the form of trunks, stumps and branches (> 10 cm diameter) in sufficient quantity to significantly hinder tillage, planting and harvesting operations.

M - Moisture limitation: This subclass consists of soils where crops are adversely affected by droughtiness owing to inherent soil characteristics. They are usually soils with low water-holding capacity.

N - Salinity: Designates soils which are adversely affected by the presence of soluble salts.

P - Stoniness: This subclass is made up of soils sufficiently stony to significantly hinder tillage, planting, and harvesting operations. Stony soils are usually less productive than comparable non-stony soils.

R - Consolidated bedrock: This subclass includes soils where the presence of bedrock near the surface restricts their agricultural use. Consolidated bedrock at depths greater than 1 meter from the surface is not considered as a limitation, except on irrigated lands where a greater depth of soil is desirable.

T - Topography: This subclass is made up of soils where topography is a limitation. Both the percent of slope and the pattern or frequency of slopes in different directions are important factors in increasing the cost of farming over that of smooth land, in decreasing the uniformity of growth and maturity of crops, and in increasing the hazard of water erosion.

W - Excess water: Subclass W is made up of soils where excess water other than that brought about by inundation is a limitation to their use for agriculture. Excess water may result from inadequate soil drainage, a high water table, seepage or runoff from surrounding areas.

X - Cumulative minor adverse characteristics: This subclass is made up of soils having a moderate limitation caused by the cumulative effect of two or more adverse characteristics which singly are not serious enough to affect the class rating.

Table 6. Agricultural Interpretations of Soils in the Study Area

Map Symbol and Phase	Soil Name	Agricultural Capability Class	Irrigation Suitability
BCK	Black Lake	2I	3S
BKA	Birkenhead	5M	4S
BMG	Blumengart	3DW	4S
BNF	Blumenfeld	3W	4D
BNF /xxxs	Blumenfeld	3WN	4D
BUM	Blumenort	3W	4DS
CTZ	Chortitz	3I	3D
CTZ /xcxx	Chortitz	3I	3D
DCS	Dencross	2W	4SD
DCS /xcxx	Dencross	2W	4SD
DCS /xxxs	Dencross	3N	4SD
DFS	Dufresne	5WI	4D
DGS	Dugas	2W	4S
DGS1	Dugas	2W	4S
DGS /xxxs	Dugas	3N	4S
DGS1 /xxxs	Dugas	3N	4S
DHO	Deadhorse	2W	4S
DHO1	Deadhorse	2W	4S
DHO /xxxs	Deadhorse	3N	4S
DHO1 /xxxs	Deadhorse	3N	4S
DNH	Denham	1	3S
DNH /xcxx	Denham	2T	3S
EBG	Edenburg	1	1
EDK	Edkins	3W	4DS
EDK /xxxs	Edkins	3WN	4DS
EEK	Elm Creek	2M	3SD
EGF	Eigenhof	1	1
EGF /xcxx	Eigenhof	2T	2T
GDH	Gnadenthal	1	2D
GDH2	Gnadenthal	1	2D
GDH /xxxs	Gnadenthal	3N	3S
GDH /xcxx	Gnadenthal	2T	2D
GOO	Glenmoor	3W	4D
GOO /xxxs	Glenmoor	3WN	4DS
GRA	Gretna	3D	4S
GRA /xxxs	Gretna	3DN	4S
GYV	Graysville	1	3SD
GYV /xxxs	Graysville	3N	3SD
HDN	Hoddinott	2W	4SD
HHF	Hochfeld	3M	2S

Table 6. Agricultural Interpretations of Soils in the Study Area(Cont'd)

Map Symbol and Phase	Soil Name	Agricultural Capability Class	Irrigation Suitability
HHF /1xxx	Hochfeld	3M	2S
HHF /0xxx	Hochfeld	3M	2S
HIN	Hibsin	2M	3S
HND	Horndean	2W	4S
HND1	Horndean	2W	4S
JOD	Jordan	1	3S
JOD1	Jordan	1	3S
JST	Jasset	1	2D
KOT	Kronstal	2M	2SD
LEW	Loewen	5WI	4D
LKD	Lakeland	2W	2D
MRS	Morris	2W	4S
MRS /xxxs	Morris	3N	4S
MYT	Myrtle	1	4S
NBG	Neuenberg	1	2D
NBG /xcxx	Neuenberg	2T	2DT
NBG /1cxx	Neuenberg	2T	2DT
NBG /2cxx	Neuenberg	2T	2DT
NUH	Neuhorst	1	2D
NUH /xcxx	Neuhorst	2T	2DT
NUH2	Neuhorst	1	2D
NUH /xxxs	Neuhorst	3N	3S
NWN	Newton Siding	1	2D
NWN2	Newton Siding	1	2D
NWN /xcxx	Newton Siding	2T	2DT
NWN /xxxs	Newton Siding	3N	3S
NWN2 /xxxs	Newton Siding	3N	3S
OBO	Osborne	3W	4D
OBO /xxxs	Osborne	3WN	4D
OBO /xxxt	Osborne	4N	4DS
OWK	Osterwick	3W	4D
PME	Plum Coulee	2W	4S
PME1	Plum Coulee	2W	4S
PME /xxxs	Plum Coulee	3N	4S
RBK	Rosebank	2M	3SD
RFD	Reinfeld	1	1
RGD	Rignold	1	3SD
RIV	Red River	2W	4S
RIV /xxxs	Red River	3N	4S
RIV /xxxt	Red River	4N	4S

Table 6. Agricultural Interpretations of Soils in the Study Area(Cont'd)

Map Symbol and Phase	Soil Name	Agricultural Capability Class	Irrigation Suitability
RLD	Reinland	2M	2SD
RLD /1xxx	Reinland	2M	2SD
RLD /0xxx	Reinland	2M	2SD
RSG	Rosengart	1	1
RSG /xcxx	Rosengart	2T	2T
RWL	Rathwell	1	2D
SCY	Scanterbury	2W	4S
SRE	Seine River	2I	4DS
WIK	Winkler	1	3S
WIK1	Winkler	1	3S

Table 7. Areal Extent in Hectares and Percent Coverage by Soil Series and Phases in the R.M. of Rhineland.

SOIL CODE		AREA	PERCENT
$ML		1436.20	1.5118
BCK	xxxx	83.86	0.0883
BKA	xxxx	5.61	0.0059
BMG	xxxx	305.60	0.3217
BNF	xxxx	116.87	0.1230
BNF	xxxs	4.32	0.0045
BUM	xxxx	5.04	0.0053
CTZ	xcxx	1016.24	1.0697
CTZ	xxxx	406.43	0.4278
DCS	xcxx	3.01	0.0032
DCS	xxxx	3079.32	3.2414
DCS	xxxs	11.90	0.0125
DFS	xxxx	97.53	0.1027
DGS	xxxx	1302.28	1.3708
DGS1	xxxx	183.92	0.1936
DGS	xxxs	1.32	0.0014
DHO	xxxx	3576.12	3.7644
DHO1	xxxx	229.44	0.2415
DHO1	xxxs	198.44	0.2089
DHO	xxxs	532.25	0.5603
DNH	xcxx	28.81	0.0303
DNH	xxxx	242.22	0.2550
EBG	xxxx	198.83	0.2093
EDK	xxxx	0.65	0.0007
EDK	xxxs	4.19	0.0044
EGF	xcxx	13.70	0.0144
EGF	xxxx	4523.59	4.7618
GDH	xcxx	57.86	0.0609
GDH	xxxx	8539.32	8.9889
GDH2	xxxx	79.92	0.0841
GDH	xxxs	886.97	0.9337
GOO	xxxx	550.04	0.5790
GRA	xxxx	935.49	0.9847
GRA	xxxs	1735.43	1.8268
GYV	xxxx	4959.25	5.2203
GYV	xxxs	17.90	0.0188
HDN	xxxx	1059.59	1.1154
HHF	xxxx	548.88	0.5778
HHF	lxxx	17.74	0.0187
HIN	xxxx	9.32	0.0098
HND	xxxx	783.35	0.8246
HND1	xxxx	122.76	0.1292
JOD	xxxx	275.33	0.2898
JOD1	xxxx	70.24	0.0739
JST	xxxx	28.05	0.0295
KOT	xxxx	1.04	0.0011
LEW	xxxx	403.38	0.4246
LKD	xxxx	946.12	0.9959
MRS	xxxx	3350.14	3.5265
MRS	xxxs	93.69	0.0986

SOIL CAPABILITY CLASS FOR AGRICULTURE	AREA (HA)	PERCENT OF AREA
Class 1	36564.	38.5%
Class 2	38242.	40.3%
Class 3	17139	18.%
Class 4	90.5	.10%
Class 5	506.	.53%
Soils Affected by salinity	5468.	5.75%

DRAINAGE

Poor	11.13%
Imperfect	78.09%
Well	8.8%

Table 7. Areal Extent in Hectares and Percent Coverage by Soil Series and Phases in the R.M. of Rhineland (Cont'd)

SOIL	CODE	AREA	PERCENT
MYT	xxxx	62.06	0.0653
NBG	2cxx	7.96	0.0084
NBG	xcxx	69.05	0.0727
NBG	xxxx	6640.89	6.9905
NBG	1cxx	11.46	0.0121
NUH	xcxx	5.52	0.0058
NUH	xxxx	2466.40	2.5963
NUH	xxxs	118.71	0.1250
NWN	xcxx	8.95	0.0094
NWN	xxxx	1956.96	2.0600
NWN2	xxxx	35.24	0.0371
NWN2	xxxs	21.28	0.0224
NWN	xxxs	159.36	0.1678
OBO	xxxx	8417.47	8.8606
OBO	xxxs	1002.59	1.0554
OBO	xxxt	12.58	0.0132
PME	xxxx	14090.65	14.8325
PME1	xxxx	746.60	0.7859
PME	xxxs	385.78	0.4061
RBK	xxxx	239.92	0.2526
RFD	xxxx	92.88	0.0978
RGD	xxxx	3401.68	3.5808
RIV	xxxx	4472.80	4.7083
RIV	xxxs	203.13	0.2138
RIV	xxxt	77.93	0.0820
RLD	xxxx	1689.62	1.7786
RLD	1xxx	5.08	0.0053
RSG	xcxx	10.36	0.0109
RSG	xxxx	682.06	0.7180
RWL	xxxx	1202.93	1.2663
SCY	xxxx	1662.98	1.7505
SRE	xxxx	403.15	0.4244
WIK	xxxx	1114.49	1.1732
WIK1	xxxx	440.40	0.4636
*** Total ***		94998.42	100.0000

Table 7. Areal Extent in Hectares and Percent Coverage by Soil Series in the R.M. of Rhineland

SERIES	AREA	PERCENT
$ML	1436.20	1.5118
BCK	83.86	0.0883
BKA	5.61	0.0059
BMG	305.60	0.3217
BNF	121.19	0.1276
BUM	5.04	0.0053
CTZ	1422.67	1.4976
DCS	3094.23	3.2571
DFS	97.53	0.1027
DGS	1487.52	1.5658
DHO	4536.25	4.7751
DNH	271.03	0.2853
EBG	198.83	0.2093
EDK	4.84	0.0051
EGF	4537.29	4.7762
GDH	9564.07	10.0676
GOO	550.04	0.5790
GRA	2670.92	2.8115
GYV	4977.15	5.2392
HDN	1059.59	1.1154
HHF	566.62	0.5965
HIN	9.32	0.0098
HND	906.11	0.9538
JOD	345.57	0.3638
JST	28.05	0.0295
KOT	1.04	0.0011
LEW	403.38	0.4246
LKD	946.12	0.9959
MRS	3443.83	3.6251
MYT	62.06	0.0653
NBG	6729.36	7.0837
NUH	2590.63	2.7270
NWN	2181.79	2.2967
OBO	9432.64	9.9293
PME	15223.03	16.0245
RBK	239.92	0.2526
RFD	92.88	0.0978
RGD	3401.68	3.5808
RIV	4753.86	5.0041
RLD	1694.70	1.7839
RSG	692.42	0.7289
RWL	1202.93	1.2663
SCY	1662.98	1.7505
SRE	403.15	0.4244
WIK	1554.89	1.6368
*** Total ***		
	94998.42	100.0000

Irrigation Suitability

Irrigation suitability of soils is determined by evaluating the nature of both internal and external soil characteristics (PFRA, 1964). The classification of soils for irrigation suitability consists of two categories: class, and subclass.

The suitability class groups soils having the same relative suitability or degree of limitation or hazard for irrigation use. Four classes are utilized grading from Class 1, which is very good to Class 4, which is poor.
The four classes are:

Class 1 - Very good: These are soils of fine sandy loam to clay loam texture which are well suited for irrigation use. The soils have good water retention capacity, good permeability, low salt content, good drainage and low general gradient of land surface.

Class 2 - Good: These are soils of loamy fine sand to light clay texture which are moderately well suited for irrigation use. Slight limitation to use results from soil factors such as water holding capacity, permeability, depth of material, salt content, topographic factors such as slope and pattern or drainage restrictions arising from surface drainage and depth to water table.

Class 3 - Fair: These are coarse or fine textured soils which are fair to marginally suitable because of some unfavourable characteristics that limit production and cause management problems under irrigation use. Soil, topographic or drainage factors are more restrictive than in Class 2.

Class 4 - Poor: These are soils that are considered poor to unsuitable for irrigation use because of severe drainage problems, impermeable geologic material, salinity, very low water holding capacity, very rapid permeability, topography or a combination of these problems.

The suitability subclass identifies soils with similar kinds of limitations and hazards related to both internal and external soil characteristics. The internal characteristics include both permanent and non-permanent properties; the permanent properties are those that will not change over time whereas the non-permanent properties may be altered with time by specific management. The properties which affect irrigation suitability of soil are listed as follows:

1. Internal Characteristics

   a) Permanent - Texture, uniformity and depth of geologic deposit, hydraulic conductivity and water storage capacity

   b) Non-permanent - Structure, drainage, fertility, reaction, salinity, exchangeable sodium

2. External Characteristics

   a) Topography, erosion, stoniness, vegetative cover

The classification criteria for irrigation suitability are summarized in Table 14, Appendix B. The soils of the study area are evaluated for irrigation suitability in Table 6.

4.4 SOIL SUITABILITY FOR SELECTED ENGINEERING USES

This section provides information which can be used by engineers and land use planners concerned with engineering and related geotechnical aspects of soil. It is intended to supplement the information on the soil map with additional data on engineering properties of soils.

The criteria used to evaluate soil suitability for selected engineering and related recreational uses are adopted from guides found in Coen et al (1977), and from guidelines developed by the Soil Conservation Service, United States Department of Agriculture (USDA, 1971), and the Canada Soil Survey Committee (CSSC, 1973).

Definition of Soil Suitability Classes

Evaluation of soil suitability for engineering and recreation uses is based on both internal and external soil characteristics. Four soil suitability classes are used to evaluate both mineral and organic soils and hence, mapping units for selected uses. These

ratings express relative degrees of suitability or limitation for potential uses of natural or essentially undisturbed soils. The long term effects of the potential use on the behaviour of the soil are considered in the rating.

The four suitability class ratings are defined as follows:

(G) Good - Soils in their present state have few or minor limitations that would affect the proposed use. The limitations would easily be overcome with minimal cost.

(F) Fair - Soils in their present state have one or more moderate limitations that would affect the proposed use. These moderate limitations would be overcome with special construction, design, planning or maintenance.

(P) Poor - Soils in their present state have one or more severe limitations that would severely affect the proposed use. To overcome these severe limitations would require the removal of the limitation or difficult and costly alteration of the soil or of special design or intensive maintenance.

(V) Very Poor - Soils have one or more features so unfavourable for the proposed use that the limitation is very difficult and expensive to overcome or the soil would require such extreme alteration that the proposed use is economically impractical.

Soil Suitability Subclasses

The basic soil properties that singly or in combination with others commonly affect soil suitability for selected engineering properties and recreation uses are provided in Table 8. These subclass designations serve to identify the kind of limitation or hazard for a particular use.

Guides for Assessing Soil Suitability

Guides for assessing soil suitability for ten engineering related uses are given in Appendix B, Tables 15 to 24. These tables provide as specifically as possible, definitions of the soil properties which result in the specific suitability or degree of limitation. In assessing soil suitability for various engineering uses, the degree of suitability is determined by the most restrictive or severe rating assigned to any one of the listed soil properties. For example, if the suitability is "Good" for all but one soil property and it is estimated to be "Very Poor", then the overall rating of the soil for that selected use is "Very Poor". Suitability of individual soil properties, if estimated to be "Fair" or "Poor", can be accumulative in their effect for a particular use. Judgement is required to determine whether the severity of the combined effects of several soil properties on suitability for a particular use will result in downgrading an evaluation. This is left to the discretion of the interpreter. It is incorrect to assume that each of the major soil properties influencing a particular use has an equal effect. Class limits established for rating the suitability of individual soil properties take this into account. For a selected use, therefore, only those soil properties which most severely limit that use are specified.

Engineering description of the soils and their estimated properties significant to engineering are provided in Table 9. These data, in addition to information contained in other sections of the report have been used to rate the soils according to their suitability for ten selected engineering uses in Table 10. When using these interpretations, consideration must be given to the following assumptions:

1. Interpretations are based on predictions of soil behaviour under defined conditions of use and management as specified in the preamble to each of Tables 15 through 28 (Appendix B).

2. Soil ratings do not include site factors such as nearness to towns and highways, water supply, aesthetic values, etc.

3. Soil ratings are based on natural, undisturbed soil.

4. Soil suitability ratings are usually given for the entire soil, but for some uses, they may be based on the limitations of an individual soil horizon or other earthy layer, because of its overriding importance. Ratings rarely apply to soil depths greater than 1 to 2 meters, but in some kinds of soils, reasonable estimates can be given for soil material at greater depths. It should be noted here that the term "soil" has been used throughout the report in the pedologic sense and differs in concept from that commonly used by engineers.

5. Poor and very poor soil ratings do not imply

that a site cannot be changed to remove, correct or modify the soil limitations. The use of soils rated as poor depends on the nature of the limitations, whether or not the soil limitation can be altered successfully and economically, and on the scarcity of good sites.

6. Interpretations of map units do not eliminate the need for on-site evaluation by qualified professionals. Due to the variable nature of soils, and the scale of mapping, small, unmappable inclusions of soils with different properties may be present in an area where a development is planned. The need for or importance of on-site studies depends on the use to be made of the soil and the kinds of soil and soil problems involved.

4.5 SOIL SUITABILITY FOR SELECTED RECREATION USES

This section provides interpretations of the soil suitability for recreational development. All types of soil can be used for recreational activities of some kind.

Soils and their properties determine to a large degree, the type and location of recreational facilities. Wet soils are not suitable for campsites, roads, playgrounds or picnic areas. Soils that pond and dry out slowly after heavy rains present problems where intensive use is contemplated. It is difficult to maintain grass cover for playing fields and golf courses on droughty soils. The feasibility of many kinds of outdoor activities are determined by other basic soil properties such as depth to bedrock, stoniness, topography or land pattern, and the ability of the soil to support vegetation of different kinds as related to its natural fertility.

The suitability of the various soil series and phases for selected recreation uses is shown in Table 11 according to four classes, Good, Fair, Poor and Very poor defined previously in the section on Engineering Uses. Subclasses are employed to identify the kind of limitation or hazard for a particular use. An explanation of subclass symbols is provided in Table 8.

The guidelines for various recreation uses are presented in Appendix B, Tables 25 to 28 and 18.

Table 8. Codes utilized to identify limitations in evaluating soil suitability for selected Engineering and Recreational Uses (Table 10 and 11)

a	subgrade properties
b	thickness of topsoil
c	coarse fragments on surface
d	depth to bedrock
e	erosion or erodibility
f	susceptibility to frost hazard
g	contamination hazard of groundwater
h	depth to seasonal water table
i	flooding or inundation
j	thickness of slowly permeable material
k	permeability or hydraulic conductivity
l	shrink-swell properties
m	moisture limitations or deficit
n	salinity or sulphate hazard
o	organic matter
p	stoniness
q	depth to sand or gravel
r	rockiness
s	surface texture
t	topographic slope class
u	moist consistence
w	wetness or soil drainage class
z	permafrost

Table 9. Engineering Description of the Soils and Their Estimated Properties Significant to Engineering

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Disturbed Hydraulic Conductivity (cm/hr)	Reaction (pH)	Electrical Conductivity (mS/cm)	Sulphate Hazard	Shrink-Swell Potential	Depth to Seasonal Water Table (m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
BCK	Black Lake	0-40	C	CH	A-7-6	100	100	95-100	.01-.5	7.0-7.4	-	none	high	subject to flooding
		40-100	C	CH	A-7-6	100	100	85-100	.01-.5	7.5-7.8	<0.5	slight	high	
BKA	Birken-head	0-35	FS	SM to SP	A-2-4	100	70-85	5-15	15.0-25.0+	7.6	0.4	low	low	
		35-60	S	SM to SP	A-2-4	95-100	70-85	5-15	15.0-25.0+	7.8	0.4	low	low	
		60-70	S-FS	SM to SP	A-2-4	95-100	70-85	5-15	15.0-25.0+	7.9	0.3	low	low	>1.2
		70-90	LS	SM to SP	A-2-4	95-100	70-85	5-15	15.0-25.0+	7.9	0.3	low	low	
		90-120	FS	SM to SP	A-2-4	95-100	70-85	5-15	15.0-25.0+	7.9	0.3	low	low	
BMG	Blumengart	0-30	SiC-C	CH to OH	A-7-6	100	100	95-100	0.1-0.25	7.5-7.8	0.5	low	high	0.8
		30-60	SiC-C	CH to MH	A-7-6	100	100	95-100	0.1-0.25	7.8-8.1	1.0	mod.	high	
		60-70	SiC-C	CH to MH	A-7-6	100	100	95-100	0.1-0.25	7.8-8.1	>2.0	mod.	high	
BNF	Blumen-feld	0-45	L	CL to OL	A-6	100	98-100	55-75	2.5-5.0	8.0	0.7	mod.	mod.	at surface
		45-80	VFSL-CL	CL to ML	A-6,A-4	100	98-100	55-75	2.5-5.0	8.0	1.6	mod.	mod.	
		80-120	L-CL	CL to ML	A-6,A-4	100	98-100	50-75	2.5-5.0	8.0	>1.6	mod.-high		
BUM	Blumenort	0-30	SiC-C	CH to OH	A-7-6	100	100	95-100	0.1	7.0-7.5	0.5	low	high	at surface
		30-60	SiC-C	CH to MH	A-7-6	100	100	95-100	0.1	7.0-7.5	>2.0	mod.	high	
CTZ	Chortitz	30-60	L-CL	MH to CL	A-7-6,A-6	100	100	98-100	1.5-7.5	8.0	<0.5	low	mod.	subject to flooding
		60-120	L-CL	MH to CL	A-7-6,A-6	100	100	98-100	1.5-7.5	8.0	<1.6	low-mod.	mod.	
DCS	Dencross	0-40	C	CH	A-7-6	100	100	95-100	.5-2.0	6.5-7.2	-	none	high	seasonal
		40-85	SiL-SiCL	ML to CL	A-4,A-6	100	100	90-95	.5-6.0	7.6-8.0	<1.6	slight	mod.	1.3 m
DFS	Dufresne	0-30	SiC-C	CH	A-7-6	100	100	95-100	.5-2.0	6.8-7.4	-	none	high	subject to flooding
		30+	C	CH	A-7-6	100	100	95-100	<.5	7.5-8.0	<1.6	low	high	
DGS	Dugas	0-25	SiC-C	MH to OH	A-7-6	100	100	95-100	0.1-0.25	6.5-7.4	<1.6	low-mod.	high	0.8
		25-80	SiC-C	CH	A-7-6	100	100	85-95	0.1-0.25	7.2-7.4	<1.6	low-mod.	high	
		80-100	FS-LVFS	SM to ML	A-2-4,A-4	100	100	15-80	5.0-12.5	7.8-8.2	<1.6	low-mod.	low	
DHO	Deadhorse	0-30	C-SiC	OH	A-7-6	100	100	90-100	0.03-2.5	6.5-7.4	<2.0	low	high	
		30-60	C-SiC	CH to MH	A-7-6	100	100	90-100	0.03-2.5	7.4-8.0	>2.0	low-mod.	high	0.8
		60-120	C-SiC	CH to MH	A-7-6	100	100	90-100	0.03-2.5	8.0-8.2	>2.0	high	high	
DNH	Denham	0-30	L-CL	OL	A-4,A-6	100	100	85-100	1.5-5.0	6.8-7.4	<0.5	low	low-mod.	
		30-90	VFSL-CL	ML to CL	A-4,A-6	100	100	85-100	1.5-5.0	7.0-7.4	<0.5	low	low-mod.	>1.5
		90-110	C	CH	A-7-6	100	100	90-100	0.5	7.8-8.2	<0.5	low	high	
EBG	Edenburg	30-90	CL-SiCL	CL	A-6	100	100	90-100	1.5-5.0	7.0-7.4	< .5	low	mod.	>1.5
		90-110	LFS-FS	SM to ML	A-2-4	100	100	10-35	5-15	7.8-8.2	<1.6	low-mod.	low	
EDK	Edkins	0-35	L	OL	A-4,A-6	100	100	55-75	3.5-5.0	6.8-7.4	<1.6	mod.	mod.-high	at or near surface
		35-85	FSL-SCL	CL to MH	A-6	100	100	60-70	3.5-5.0	7.8-8.0	<1.6	mod.	mod.-high	
		85-110	C	CH to MH	A-7-6	100	100	100	<0.1	7.8-8.0	>2.0	high	high	
EGF	Eigenhof	0-30	CL	CL to MH	A-7-6	100	100	75-100	0.2-1.0	6.5-7.4	<0.5	low	mod.-high	
		30-60	CL-SiC	CL to MH	A-7-5	100	95-100	75-95	1.0-2.0	7.1-7.3	<0.5	low	mod.-high	2.0
		60-120	CL	CL to MH	A-7-5	100	95-100	75-95	0.2-1.0	7.6-7.8	<1.6	mod.	mod.	
GDH	Gnaden-thal	0-30	L	OL	-	100	100	55-75	1.5-5	6.8-7.4	0.5-1.6	low-mod.	mod.	0.8
		30-60	VFSL-L	ML to CL	A-4,A-6	100	95-100	65-75	1.5-5	8.0-8.2	0.5-1.6	low-mod.	mod.	
		60-120	VFSL-SiCL	ML to CL	A-4,A-6	100	95-100	65-75	0.5-5	8.0-8.2	>1.6	high	mod.	

Table 9. Engineering Description of the Soils and Their Estimated Properties Significant to Engineering (Cont'd)

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Disturbed Hydraulic Conductivity (cm/hr)	Reaction (pH)	Electrical Conductivity (mS/cm)	Sulphate Hazard	Shrink-Swell Potential	Depth to Seasonal Water Table (m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
GOO	Glenmoor	0-40	C	CH	A-7-6	100	100	95-100	.5-2.0	7.4-7.8	<0.5	low	high	seasonal
		40-100	SiL-SiCL	ML to CL	A-4 to A-6	100	100	85-95	2.5	7.8-8.2	1.6	mod.	mod.	near
		100+	C	CH	A-7-6	100	100	95-100	0.1	7.6-8.0	>1.6	mod.-high	high	surface
GRA	Gretna	30-60	C	CH	A-7-6	100	100	100	<.15	8.0-8.2	>2	high	high	<1.2
		60-120	C	CH	A-7-6	100	100	100	<.15	8.0-8.2	>2	high	high	
GYV	Grays-ville	30-90	VFSL-CL	ML to CL	A-5,A-7-6	100	100	65-80	2.5-6.5	7.6-8.2	<1.6	mod.	mod.	0.8
		90-100	C	CH to MH	A-7-6	100	100	95-100	.03-.1	7.8-8.2	>1.6	mod.-high	high	
HDN	Hoddinott	0-40	C	CH	A-7-6	100	100	95-100	.1-2.0	6.5-7.0	<1.6	low	high	seasonal
		40-85	SiL-SiCL	ML to CL	A-4,A-7-5	100	95-100	85-95	<2.5	7.4-7.8	<1.6	low	mod.	within
		85+	C	CH	A-7-6	100	100	95-100	<.25	7.6-8.0	>2.0	mod. to high	high	.5 m
HHF	Hochfeld	0-30	VFS-FSL	SM to SP	A-2,A-4	100	90-100	5-40	5.0-12.0	6.5-7.0	<0.5	low	low	
		30-85	VFS-FSL	SM to SP	A-2-4,A-4	100	90-100	30-70	5.0-12.0	7.2-7.6	<0.5	low	low	>1.2
		85-110	FS-LVFS	SM to ML	A-2,A-4	100	90-100	20-70	7.5-15.0	7.8-8.2	<1.6	low-mod.	low	
HIN	Hibsin	0-30	FS	SM	A-2-4	100	90-100	1-10	5.0-12.0	6.5-7.4	<0.5	low	low	
		30-85	VFS-FSL	SM to SP	A-2,A-4	100	90-100	25-70	5.0-12.0	7.2-7.6	<0.5	low	low	>1.5
		85-100	SiC-C	CH to MH	A-7-6	100	100	95-100	0.1-0.25	7.8-8.2	<1.6	low-mod.	high	
HND	Horndean	30-80	C-SC	CH to MH	A-7-6	100	100	85-95	.15-.5	7.2-7.6	<1.6	low-mod.	high	1.2
		80-110	FS-LVFS	SM to ML	A-2,A-4	100	100	40-70	5-15	7.8-8.2	>2	mod.-high	low	
JOD	Jordan	30-85	SiC-C	CH to MH	A-7-6	100	100	85-95	1.5-5	7.0-7.6	< .5	low	high	>1.5
		85-110	FS-LVFS	SM to ML	A-2,A-4	100	100	15-70	5-15	7.8-8.2	<1.6	low-mod.	low	
JST	Jasset	30-80	VFSL-L	ML to CL	A-5	100	95-100	65-75	2.6	7.0-7.4	<0.5	low	mod.	1.2
		80-110	FS-LVFS	SM to ML	A-2,A-4	100	100	15-70	5-12	7.8-8.2	<1.6	low-mod.	low	
KOT	Kronstal	0-40	FSL	SM	A-2,A-4	100	95-100	5-35	5.0-15.0	6.5-7.4	<0.5	low	low	
		40-90	VFS-FSL	ML to SM	A-4,A-2-4	100	100	25-60	5.0-15.0	7.0-7.4	<0.5	low	low	1.2
		90-110	FS-LFS	SM to SW	A-2-4,A-3	100	95-100	15-35	15.0-35.0	7.8-8.2	<1.6	low-mod.	low	
LEW	Loewen	30-60	L-CL	MH to CL	A-7-6	100	100	98-100	1.0-2.0	8.0	<1.6	mod.	mod.-high	flood prone
		60-120	L-CL	MH to CL	A-7-6	100	100	98-100	<1.0	8.0	>2	mod.	mod.-high	
LKD	Lakeland	0-25	CL	CL	A-7-6	100	100	90-100	1.5-2.5	7.2-7.4	<1.6	low	mod.	seasonal
		25-75	SiL-SiCL	ML to CL	A-4,A-7-6	100	95-100	80-95	1.5	7.6-8.0	1.6	mod.	mod.	.7 m
		75	SiL-SiCL	ML to CL	A-4,A-7-6	100	95-100	80-95	.5	7.6-8.0	>1.6	mod.	mod.	
MRS	Morris	30-65	C	CH	A-7-6	100	100	100	<.15	7.0-7.4	<1.6	low-mod.	high	<1.5
		65-100	C	CH	A-7-6	100	100	100	<.15	7.8-8.2	>1.6	high	high	
MYT	Myrtle	0-40	C	CH to OH	A-7-6	100	100	100	1.-2.5	6.5-7.0	<.5	low	high	>2 m
		40-100	C	CH	A-7-6	100	100	100	<2.0	7.4-7.8	<.5	low	high	
NBG	Neuenberg	0-40	L	OL to ML	A-4,A-7-5	100	100	55-75	1.5-5.0	6.8-7.4	1.6	mod.	low	
		40-90	VFSL-L	ML to CL	A-4,A-6	100	100	40-60	1.5-5.0	7.6-8.0	1.6	mod.	low-mod.	1.0
		90-120	FS-LVFS	SM to ML	A-2-4,A-4	100	100	50-75	5.0-15.0	7.8-8.2	>1.6	mod.-high		
NUH	Neuhorst	30-70	CL,SiCL	CL to CH	A-7-5,A-7-6	100	100	70-90	.5-5	7.8-8.2	1.6	mod.	mod.	1.2
		10-110	strat. SiL-CL	ML to CL	A-4,A-6	100	100	70-90	.5-5	7.8-8.2	>1.6	mod.-high	mod.	
NWN	Newton Siding	0-20	CL	ML	A-7-6	100	100	90-100	0.5-1.5	7.2-7.6	0.5-1.5	low-mod.	mod.	
		20-80	CL	ML	A-7-6	100	100	90-100	0.5-1.5	7.2-7.6	0.5-1.5	low-mod.	mod.	1.0
		80-120	FS-VFS	SM	A-2-4,A-4	100	100	40-70	5-15	7.6-8.2	1.5-4	mod.	low	

Table 9. Engineering Description of the Soils and Their Estimated Properties Significant to Engineering (Cont'd)

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Disturbed Hydraulic Conductivity (cm/hr)	Reaction (pH)	Electrical Conductivity (mS/cm)	Sulphate Hazard	Shrink-Swell Potential	Depth to Seasonal Water Table (m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
OBO	Osborne	0-35	C	OH	A-7-6	100	100	100	0.15	6.5-7.4	<1.6	mod.	high	near
		35-100	C	CH	A-7-6	100	100	100	0.15	7.8-8.2	<1.6	mod.	high	surface
OWK	Oster-wick	0-60	FSL	SM	A-2,A-4	100	95-100	5-35	5.0-15.0	6.5-7.4	<0.5	low	low	near
		60-100	FSL	SM	A-4	100	100	35-60	7.5-10.0	8.0-8.2	<1.6	low-mod.	low	surface
		100-140	FS-FSL	SM to ML	A-4,A-2-4	100	100	35-60	1.0-5.0	8.0-8.2	<1.6	low-mod.	low	
PME	Plum Coulee	30-60	C	CH	A-7-6	100	100	95-100	0.1-1.5	7.5-7.8	<1.6	low-mod.	high	1.2
		60-120	SiCL-C	MH to CH	A-7-6	100	100	90-100	0.25-1.5	7.8-8.0	>1.6	mod.-high	high	
RBK	Rosebank	0-30	FS	SM	A-2-4	100	90-100	1-10	5.0-12.0	6.5-7.4	<0.5	low	low	
		30-85	LFS-LVFS	SM to ML	A-2-4,A-4	100	90-100	40-60	5.0-12.0	7.8-8.2	<1.6	low-mod.	low	0.8
		85-110	C,SiC	CH,MH	A-7-6	100	100	95-100	0.1	7.8-8.2	<1.6	low-mod.	high	
RFD	Reinfeld	0-50	L	OL	A-4,A-6	100	95-100	55-75	5.0-7.5	6.5-7.4	<0.5	low	low-mod.	>1.5 m
		50-100	strat. VFSL-SiCL	ML to CL	A-4,A-6	100	100	70-95	0.2-5.0	7.8-8.2	<1.6	low-mod.	low-mod.	
RGD	Rignold	0-40	L	OL	A-4,A-6	100	95-100	55-75	5.0-7.5	6.5-7.4	<0.5	low	low-mod	0.8
		40-90	VFSL-CL	ML to CL	A-4,A-6	100	100	70-100	3.0-10.0	7.4-8.0	<0.5	low	mod.	(perched)
		90-110	C	CH to MH	A-7-6	100	100	100	<0.1	7.8-8.2	<1.6	low-mod.	high	
RIV	Red River	0-30	C	OH	A-7-6	100	100	100	0.1	6.5-7.4	<1.6	low-mod.	high	1.5 m
		30-100	C	CH	A-7-6	100	100	100	0.1	7.6-8.2	<1.6	low-mod.	high	
RLD	Reinland	0-30	FSL	SM	A-2,A-4	100	95-100	5-35	7.0-15.0	6.5-7.4	<1.6	low-mod.	low	
		30-75	FSL-LVFS	SM to ML	A-2-4,A-4	100	95-100	30-85	7.0-15.0	7.8-8.2	<1.6	low-mod.	low	>1.2
		75-110	FS-LVFS	SM to ML	A-2-4,A-4	100	95-100	25-75	7.0-20.0	7.8-8.2	1.6	mod.	low	
RSG	Rosen-gart	0-35	L-CL	OL	A-4,A-6	100	95-100	55-75	1.0-5.0	6.5-7.4	<0.5	low	low	
		35-80	VFSL-L-SiL	ML	A-4	100	100	90-100	1.0-5.0	7.2-7.8	<0.5	low	low	>1.5
		80-110	FS-LVFS	SM to ML	A-2-4,A-4	100	100	25-75	7.0-20.0	7.8-8.2	<1.6	low-mod.	low	
RWL	Rathwell	30-70	CL,SiCL	CL to CH	A-7-5,A-7-6	100	100	70-90	.5-.5	7.8-8.2	1.6	mod.	mod.	1.2
		70-110	strat. SiL-CL	ML to CL	A-4,A-6	100	100	70-90	.5-.5	7.8-8.2	>1.6	mod.-high	mod.	
SCY	Scanter-bury	0-25	C	OH	A-7-6	100	100	90-100	<0.5	6.6-7.0	-	low	high	1.5 m
		25-60	C	CH	A-7-6	100	100	90-100	<0.5	7.0-7.6	<0.3	low	high	
		60+	C	CH	A-7-6	100	100	90-100	<0.1	7.8-8.2	<1.6	low-mod.	high	
SRE	Seine River	0-25	SiC	OH	A-7-6	100	100	95-100	.5-2.0	6.5-7.0	<.5	low	high	occa-
		25-60	SiC-C	CH	A-7-6	100	100	95-100	<.5	7.2-7.4	<.5	low	high	sional
		60+	C	CH	A-7-6	100	100	95-100	<.1	7.4-7.8	<1.6	mod.	high	flooding
WIK	Winkler	0-30	CL-C	CH	A-7-6	100	100	90-100	1.0-2.5	6.8-7.0	<0.5	low	high	
		30-60	C	CH	A-7-6	100	100	90-100	0.1-0.25	7.5-7.8	<0.5	low	high	2 m
		60-120 strat.	SiCL-C	CH,MH	A-7-6	100	100	90-100	0.1-0.25	7.8-8.0	1.6	low-mod.	high	

Table 10. Suitability Ratings and Limitations for Soils in the Study Area for Selected Engineering Uses

Map Symbol and Phase	Soil Name	Top Soil	Sand & Gravel	Road Fill	Permanent Bldgs. With Basements	Local Roads and Streets	Sanitary Trench	Landfill Area	Cover Material	Sewage Lagoons	Septic Fields
BCK	Black Lake	Ps	Va	Pa	Pia	Pa	Pis	Pi	Ps	Pi	Pik
BKA	Birkenhead	Ps	G	G	G	G	Vks	Vk	Vs	Vka	Gg
BMG	Blumengart	Ps	Va	Pa	Paw	Pa	Phs	Fw	Ps	Pi	Vk
BNF	Blumenfeld	Fs	Va	Pw	Pw	Pw	Vw	Pw	Pw	Vh	Vh
BNF /xxxs	Blumenfeld	Pn	Va	Pw	Pw	Pw	Vw	Pw	Pw	Vh	Vh
BUM	Blumenort	Ps	Va	Pwa	Vh	Paw	Vhw	Pwi	Psw	Pi	Vkh
CTZ	Chortitz	Fsi	Va	Faw	Pwi	Faw	Pw	Fw	Fs	Pi	Phi
CTZ /xcxx	Chortitz	Fsi	Va	Faw	Pwi	Faw	Piw	Fw	Fs	Pi	Phi
DCS	Dencross	Ps	Va	Paf	Paw	Pa	Psw	Fw	Ps	Fa	Phk
DCS /xcxx	Dencross	Ps	Va	Paf	Paw	Pa	Psw	Fw	Ps	Fat	Phk
DCS /xxxs	Dencross	Psn	Va	Paf	Pwn	Pa	Psw	Fw	Ps	Fa	Phk
DFS	Dufresne	Pi	Va	Pw	Vi	Vi	Viw	Vi	Piw	Vi	Vi
DGS	Dugas	Ps	Va	Pa	Pwa	Pa	Psw	Fw	Ps	Pk	Fk
DGS1	Dugas	Fb	Va	Pa	Pwa	Pa	Psw	Fw	Ps	Pk	Fk
DGS /xxxs	Dugas	Psn	Va	Pa	Pwa	Pa	Psw	Fw	Ps	Pk	Fk
DGS1 /xxxs	Dugas	Pn	Va	Pa	Pwa	Pa	Psw	Fw	Ps	Pk	Fk
DHO	Deadhorse	Ps	Va	Pa	Pwa	Pa	Psw	Fw	Ps	Fh	Pkh
DHO1	Deadhorse	Fsb	Va	Pa	Pwa	Pa	Psw	Fw	Ps	Fh	Pkh
DHO /xxxs	Deadhorse	Psn	Va	Pa	Pwa	Pa	Psw	Fw	Ps	Fh	Pkh
DHO1 /xxxs	Deadhorse	Pn	Va	Pa	Pwa	Pa	Psw	Fw	Ps	Fh	Pkh
DNH	Denham	Fs	Va	Fa	Fa	Fa	Ps	G	Fs	Fak	Fk
DNH /xcxx	Denham	Fs	Va	Fa	Fa	Fa	Ps	G	Fs	Fkt	Fk
EBG	Edenburg	Fs	Va	Fa	Fa	Fa	Pk	Fk	Fs	Pka	G
EDK	Edkins	Fsb	Va	Pw	Vwh	Pw	Vw	Pw	Pw	G	Vh
EDK /xxxs	Edkins	Pn	Va	Pw	Vhw	Pw	Vw	Pw	Pw	G	Vh
EEK	Elm Creek	Ps	Pa	Fw	Pw	Fw	Pw	Pk	Fs	Fa	Fk
EGF	Eigenhof	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fk	Fk
EGF /xcxx	Eigenhof	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fkt	Fk
GDH	Gnadenthal	G	Va	Faw	Pw	Faw	Pw	Fw	G	Fak	Fk
GDH2	Gnadenthal	Fs	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fak	Fk

Table 10. Suitability Ratings and Limitations for Soils in the Study area for Selected Engineering Uses (Cont'd)

Map Symbol and Phase		Soil Name	Top Soil	Sand & Gravel	Road Fill	Permanent Bldgs. With Basements	Local Roads and Streets	Sanitary Trench	Landfill Area	Cover Material	Sewage Lagoons	Septic Fields
GDH	/xxxs	Gnadenthal	Pn	Va	Faw	Pw	Faw	Pw	Fw	G	Fak	Fk
GDH	/xcxx	Gnadenthal	G	Va	Faw	Pw	Fwa	Pw	Fw	G	Fat	Fk
GOO		Glenmoor	Ps	Va	Paw	Pwa	Paw	Vw	Pw	Psw	Fa	Vh
GOO	/xxxs	Glenmoor	Ps	Va	Paw	Pwa	Paw	Vw	Pw	Psw	Fa	Vh
GRA		Gretna	Ps	Va	Pa	Paw	Pa	Ps	Fw	Ps	G	Vk
GRA	/xxxs	Gretna	Psn	Va	Pa	Paw	Pa	Ps	Fw	Ps	G	Vk
GYV		Graysville	Fs	Va	Faw	Pw	Faw	Psw	Fw	Fs	Fak	Ph
GYV	/xxxs	Graysville	Pn	Va	Faw	Pw	Faw	Psw	Fw	Fs	Fak	Ph
HDN		Hoddinott	Ps	Va	Paf	Pwa	Pa	Psw	Fw	Ps	Fah	Phk
HHF		Hochfeld	G	Va	G	G	G	Pk	Pk	G	Pk	G
HHF	/1xxx	Hochfeld	G	Va	G	G	G	Pk	Pk	G	Pk	G
HHF	/0xxx	Hochfeld	G	Va	G	G	G	Pk	Pk	G	Pk	G
HIN		Hibsin	Ps	Pa	Fa	Pa	G	Ps	Pk	Fs	Fa	Fk
HND		Horndean	Ps	Va	Pa	Pwa	Pa	Psh	Fw	Ps	Pk	Fk
HND1		Horndean	Fb	Va	Pa	Pwa	Pa	Psh	Fw	Ps	Pk	Fk
JOD		Jordan	Ps	Va	Pa	Pa	Pa	Fs	Fh	Ps	Pak	Fk
JOD1		Jordan	Fs	Va	Pa	Pa	Pa	Fs	Fh	Ps	Pak	Fk
JST		Jasset	G	Va	Faw	Pw	Faw	Pkh	Pk	G	Pk	Fh
KOT		Kronstal	G	Va	Fwa	Pw	Fwa	Phk	Pk	G	Pk	Fhk
LEW		Loewen	Pi	Va	Pw	Vi	Vi	Viw	Vi	Pw	Vi	Vi
LKD		Lakeland	Fs	Va	Faw	Pw	Fwa	Pw	Fw	Fs	Fak	Fhk
MRS		Morris	Ps	Va	Pa	Paw	Pa	Psw	Fw	Ps	G	Vk
MRS	/xxxs	Morris	Pns	Va	Pa	Paw	Pa	Psw	Fw	Ps	G	Vk
MYT		Myrtle	Ps	Va	Pal	Pa	Pa	Ps	G	Ps	G	Pk
NBG		Neuenberg	G	Va	Faw	Pw	Faw	Pkw	Pk	G	Pk	Fh
NBG	/xcxx	Neuenberg	G	Va	Faw	Pw	Faw	Pkw	Pk	G	Pk	Fh
NBG	/1cxx	Neuenberg	G	Va	Faw	Pw	Faw	Pkw	Pk	G	Pk	Fh
NBG	/2cxx	Neuenberg	Fd	Va	Faw	Pw	Faw	Pkw	Pk	G	Pk	Fh
NUH		Neuhorst	Fs	Va	Faw	Pw	Fwa	Pw	Fw	Fs	Fk	Fkh
NUH	/xcxx	Neuhorst	Fs	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fkt	Fhk

Table 10. Suitability Ratings and Limitations for Soils in the Study area for Selected Engineering Uses (Cont'd)

Map Symbol and Phase	Soil Name	Top Soil	Sand & Gravel	Road Fill	Permanent Bldgs. With Basements	Local Roads and Streets	Sanitary Trench	Landfill Area	Cover Material	Sewage Lagoons	Septic Fields
NUH2	Neuhorst	Fs	Va	Faw	Pw	Fwa	Pw	Fw	Fs	Fk	Fhk
NUH /xxxs	Neuhorst	Pn	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fk	Fhk
NWN	Newton Siding	Fs	Va	Faw	Pw	Faw	Pwk	Fw	Fs	Pk	Fhk
NWN2	Newton Siding	Fs	Va	Faw	Pw	Faw	Pwk	Fw	Fs	Pk	Fh
NWN /xcxx	Newton Siding	Fs	Va	Faw	Pw	Faw	Pwk	Fw	Fs	Pk	Fh
NWN /xxxs	Newton Siding	Pn	Va	Faw	Pw	Faw	Pwk	Fw	Fs	Pk	Fh
NWN2 /xxxs	Newton Siding	Pn	Va	Faw	Pw	Faw	Pwk	Fw	Fs	Pk	Fh
OBO	Osborne	Ps	Va	Paw	Pw	Paw	Vw	Pw	Psw	G	Vhk
OBO /xxxs	Osborne	Psn	Va	Pwa	Pw	Paw	Vw	Pw	Psw	G	Vhk
OBO /xxxt	Osborne	Vn	Va	Paw	Vw	Paw	Vw	Pw	Psw	G	Vkh
OWK	Osterwick	G	Va	Pw	Pw	Pw	Vw	Pkw	Pw	Pkh	Vh
PME	Plum Coulee	Ps	Va	Pa	Pwa	Pa	Pws	Fw	Ps	Fah	Phk
PME1	Plum Coulee	Fsb	Va	Pa	Paw	Pa	Psw	Fw	Ps	Fah	Phk
PME /xxxs	Plum Coulee	Psn	Va	Pa	Pwa	Pa	Pws	Fw	Ps	Fah	Phk
RBK	Rosebank	Ps	Pa	Fw	Pw	Fw	Pw	Pk	Fs	Fa	Fk
RFD	Reinfeld	G	Va	Fa	Fa	Fa	G	G	G	Fk	Fk
RGD	Rignold	G	Va	Faw	Pw	Faw	Ps	Fw	Fs	Fak	Ph
RIV	Red River	Ps	Va	Pa	Paw	Pa	Pws	Fw	Ps	G	Vk
RIV /xxxs	Red River	Psn	Va	Pa	Paw	Pa	Pws	Fw	Ps	G	Vk
RIV /xxxt	Red River	Vn	Va	Pa	Paw	Pa	Pws	Fw	Ps	G	Vk
RLD	Reinland	G	Va	Fwa	Pw	Fwa	Pwk	Pk	G	Pk	Fh
RLD /1xxx	Reinland	Fb	Va	Fw	Pw	Fw	Pwk	Pk	G	Pk	Ph
RLD /0xxx	Reinland	G	Va	Fw	Pw	Fw	Pwk	Ph	G	Pk	Ph
RSG	Rosengart	G	Va	Fa	Fa	Fa	Pk	Pk	G	Pk	Gg
RSG /xcxx	Rosengart	G	Va	Fa	Fa	Fa	Pk	Pk	G	Pk	Gg
RWL	Rathwell	Fs	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fk	Fhk
SCY	Scanterbury	Ps	Va	Pa	Paw	Pa	Pws	Fw	Ps	G	Vk
SRE	Seine River	Psi	Va	Pa	Pai	Pai	Pwi	Pi	Ps	Vi	Phi
WIK	Winkler	Ps	Va	Pal	Pa	Pa	Ps	G	Ps	Fk	Pk
WIK1	Winkler	Ps	Va	Pal	Pa	Pa	Ps	G	Ps	Fk	Pk

Table 11. Suitability Ratings and Limitations of Soils in the Study Area for Various Recreational Uses

Map Symbol and Phase	Soil Name	Play Ground	Picnic Area	Camp Area	Path And Trails	Permanent Bldgs. Without Basements
BCK	Black Lake	Fs	Fs	Fs	Fs	Pia
BKA	Birkenhead	Ps	Pm	Fs	G	G
BMG	Blumengart	Psw	Psw	Psw	Ps	Pa
BNF	Blumenfeld	Pw	Pw	Pw	Pw	Pw
BNF /xxxs	Blumenfeld	Pw	Pwn	Pwn	Pw	Pw
BUM	Blumenort	Pw	Pw	Pw	Pw	Pw
CTZ	Chortitz	Pw	Fsw	Fsw	Fsw	Pi
CTZ /xcxx	Chortitz	Pw	Fsw	Fsw	Fws	Pi
DCS	Dencross	Ps	Ps	Ps	Ps	Pa
DCS /xcxx	Dencross	Ps	Ps	Ps	Ps	Pa
DCS /xxxs	Dencross	Ps	Psn	Psn	Ps	Pa
DFS	Dufresne	Vi	Vi	Vi	Vi	Vi
DGS	Dugas	Ps	Ps	Ps	Ps	Pa
DGS1	Dugas	Fws	Fsw	Fsw	Fsw	Pa
DGS /xxxs	Dugas	Psn	Psn	Psn	Ps	Pa
DGS1 /xxxs	Dugas	Pn	Pn	Pn	Fs	Pa
DHO	Deadhorse	Ps	Ps	Ps	Ps	Pa
DHO1	Deadhorse	Fs	Fs	Fsw	Fs	Pa
DHO /xxxs	Deadhorse	Psn	Psn	Psn	Ps	Pa
DHO1 /xxxs	Deadhorse	Pn	Pn	Pn	Fs	Pa
DNH	Denham	Fs	Fs	Fs	Fs	Fa
DNH /xcxx	Denham	Ft	Fs	Fs	Fs	Fa
EBG	Edenburg	Fs	Fs	Fs	Fs	Fa
EDK	Edkins	Pw	Pw	Pw	Pw	Pw
EDK /xxxs	Edkins	Pwn	Pwn	Pwn	Pw	Pw
EEK	Elm Creek	Fsw	Fsw	Fsw	Fw	Fw
EGF	Eigenhof	Fs	Fs	Fs	Fs	Fa
EGF /xcxx	Eigenhof	Fst	Fs	Fs	Fs	Fa
GDH	Gnadenthal	Fw	Fw	Fw	Fw	Fwa
GDH2	Gnadenthal	Ps	Ps	Ps	Ps	Faw
GDH /xxxs	Gnadenthal	Fnw	Pwn	Pwn	Fw	Fwa
GDH /xcxx	Gnadenthal	Fwt	Fw	Fw	Fw	Fwa
GOO	Glenmoor	Psw	Psw	Psw	Psw	Paw
GOO /xxxs	Glenmoor	Psn	Psn	Psw	Psw	Paw
GRA	Gretna	Pws	Psw	Psk	Ps	Pa
GRA /xxxs	Gretna	Pws	Psw	Psk	Ps	Pa
GYV	Graysville	Fw	Fw	Fw	Fw	Fw
GYV /xxxs	Graysville	Pnw	Pwn	Pwn	Fw	Fw
HDN	Hoddinott	Ps	Ps	Ps	Ps	Pa
HHF	Hochfeld	G	G	G	G	G

Table 11. Suitability Ratings and Limitations of Soils in the Study Area for Various Recreational Uses(Cont'd)

Map Symbol and Phase	Soil Name	Play Ground	Picnic Area	Camp Area	Path And Trails	Permanent Bldgs. Without Basements
HHF /1xxx	Hochfeld	G	G	G	G	G
HHF /0xxx	Hochfeld	G	G	G	G	G
HIN	Hibsin	Fs	Fs	Fs	G	Fa
HND	Horndean	Ps	Ps	Ps	Ps	Pa
HND1	Horndean	Fws	Fws	Fws	Fws	Pa
JOD	Jordan	Fs	Fs	Fs	Fs	Pa
JOD1	Jordan	Fws	Fs	Fs	Fs	Fa
JST	Jasset	Fw	Fw	Fw	Fw	Faw
KOT	Kronstal	Fw	Fw	Fw	Fw	Faw
LEW	Loewen	Pi	Pi	Vi	Pi	Vi
LKD	Lakeland	Fsw	Fsw	Fsw	Fws	Fwa
MRS	Morris	Ps	Ps	Ps	Ps	Pa
MRS /xxxs	Morris	Ps	Psn	Psn	Ps	Pa
MYT	Myrtle	Fs	Fs	Fs	Fs	Pa
NBG	Neuenberg	Fw	Fw	Fw	Fw	Faw
NBG /xcxx	Neuenberg	Fwt	Fw	Fw	Fw	Faw
NBG /1cxx	Neuenberg	Fwt	Fw	Fw	Fw	Faw
NBG /2cxx	Neuenberg	Fwt	Fw	Fw	Fw	Faw
NUH	Neuhorst	Fsw	Fsw	Fsw	Fws	Faw
NUH /xcxx	Neuhorst	Fst	Fsw	Fsw	Fsw	Faw
NUH2	Neuhorst	Ps	Ps	Ps	Ps	Faw
NUH /xxxs	Neuhorst	Fsn	Pnw	Pnw	Fws	Faw
NWN	Newton Siding	Fsw	Fsw	Fsw	Fws	Faw
NWN2	Newton Siding	Ps	Ps	Ps	Ps	Faw
NWN /xcxx	Newton Siding	Fwt	Fsw	Fsw	Fsw	Faw
NWN /xxxs	Newton Siding	Fsw	Pnw	Pnw	Fws	Faw
NWN2 /xxxs	Newton Siding	Psn	Psn	Psn	Ps	Faw
OBO	Osborne	Psw	Psw	Psw	Psw	Paw
OBO /xxxs	Osborne	Psw	Pws	Psw	Pws	Paw
OBO /xxxt	Osborne	Vwn	Vwn	Psw	Pws	Pwa
OWK	Osterwick	Pw	Pw	Pw	Pw	Pw
PME	Plum Coulee	Ps	Ps	Ps	Ps	Pa
PME1	Plum Coulee	Fs	Fs	Fsw	Fs	Pa
PME /xxxs	Plum Coulee	Psn	Psn	Psn	Ps	Pa
RBK	Rosebank	Fw	Fw	Fw	Fw	Fw
RFD	Reinfeld	G	G	G	G	Fa
RGD	Rignold	Fw	Fw	Fw	Fw	Faw
RIV	Red River	Ps	Ps	Ps	Ps	Pa
RIV /xxxs	Red River	Ps	Psn	Psn	Ps	Pa
RIV /xxxt	Red River	Ps	Pws	Pws	Ps	Pa

Table 11. Suitability Ratings and Limitations of Soils in the Study Area for Various Recreational Uses(Cont'd)

Map Symbol and Phase	Soil Name	Play Ground	Picnic Area	Camp Area	Path And Trails	Permanent Bldgs. Without Basements
RLD	Reinland	Fw	Fw	Fw	Fw	Fw
RLD /1xxx	Reinland	Fw	Fw	Fw	Fw	Fw
RLD /0xxx	Reinland	Fw	Fw	Fw	Fw	Fw
RSG	Rosengart	G	G	G	G	Fa
RSG /xcxx	Rosengart	Ft	G	G	G	Fa
RWL	Rathwell	Fsw	Fsw	Fsw	Fsw	Faw
SCY	Scanterbury	Ps	Ps	Ps	Ps	Pa
SRE	Seine River	Ps	Ps	Pis	Ps	Pa
WIK	Winkler	Fs	Fs	Fs	Fs	Pa
WIK1	Winkler	Fs	Fs	Fs	Fs	Pa

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APPENDIX A

CORRELATION OF THE SOILS IN THE RURAL MUNICIPALITY OF RHINELAND DETAILED RESURVEY WITH SOILS IN THE RECONNAISSANCE MORRIS MAP SHEET AREA, REPORT NO. 5, 1953

The detailed resurvey (1:20,000 scale) of the R.M. of Rhineland covers 93 241 hectares in the extreme southwest corner of the Morris map sheet. The resurvey benefits from advantages derived from more frequent and intensive examination of soils in the field, use of a larger mapping scale in order to permit delineation of numerous important local soils, use of modern aerial photographs and use of improved methods of studying soils in the laboratory. In particular, changes in the stratigraphy of surface deposits, depth and type of soil profile, degree of erosion, slope, stoniness and salinity are emphasized.

In the reconnaissance (1:126,720 scale) soil survey, the area involved and the scale of the map used is such that it is impossible to show each individual soil as a unit. On the reconnaissance map of the Morris Map Sheet, each unit shown, in most cases, is considered as a compound mapping unit consisting of a complex of soil types known as a "soil association", having a dominant soil type interspersed with related but unlike local soil types in lesser proportion. However, while soil associations are the primary units generally shown on the reconnaissance map, local associated soils, phases and textural classes are occasionally mapped or designated as separate units where the areas involved are substantial or where such units are of sufficient local importance. In some instances such units are identified on the reconnaissance map by site symbols or hatching.

The associated genetic soil types that are developed on similar regional materials or geological deposits in the same zone are designated as a "soil association" and the individual associated soils, which are recognized by their soil profile characteristics, are referred to as "soil associates". These soil associates can be classed as genetic soil types that have developed under different drainage or moisture conditions, namely, variation in local soil climate.

In the present detailed map of the municipality, each unit shown is either a simple unit consisting of a single soil type referred to as a "soil series" or a specifically defined compound unit containing one dominant soil series and usually one other related but unlike soil series associated with it. Soil series in terms of current Canadian Soil Classification criteria (CSSC 1987) are approximately equivalent to soil associates as defined in the 1953 study. In general, the range in allowable variation in profile characteristics and properties of soil series is significantly less than the range permitted in so-called soil associates.

The detailed resurvey of the R.M. of Rhineland provides for improved quality and reliability of the soil map for a variety of interpretive applications including, recreation, engineering and agriculture. Correlation of the soil series in the resurvey of the municipality with soil associations and soil associates of the Morris Map Sheet Area is provided in Table 12.

Table 12. Correlation of Soil Series in the R.M. of Rhineland with Soil Associations and Associates of the Morris Map Sheet Area, Report No. 5, 1953.

Soil Symbol	Soil Name	Subgroup	Soil Association or Associate of the Morris Map Sheet, 1953.	Remarks
BKA	Birkenhead	Calcareous Black	Agassiz	A significant inclusion in, and is similar to the calcareous, well drained, Blackearth member of the Agassiz Association.
BCK	Black Lake	Cumulic Regosol	Riverdale	The well drained, silty clay textured associate of the Riverdale Association developed on recent alluvium.
BNF	Blumenfeld	Rego Humic Gleysol	Altona	A minor inclusion in the Altona Association, and the same as the poorly drained, Meadow soil of the Altona very fine sandy loam grading to the Altona very fine sandy clay loam.
BMG	Blumengart	Gleyed Cumulic Regosol	Horndean Complex	Blumengart is similar to the intermediately drained, immature, alluvial soil of the Horndean Complex.
BUM	Blumenort	Rego Humic Gleysol	Horndean Complex	The same as the poorly drained, Meadow soil of the least mature Horndean Complex soils.
CTZ	Chortitz	Gleyed Cumulic Regosol	Riverdale	A significant inclusion in and the same as the intermediately drained, recent alluvial soil of the Riverdale Association.
DHO	Deadhorse	Gleyed Rego Black	Horndean Complex	The intermediately drained, Blackearth-Meadow associate of the more mature Horndean soils with a stratified (SiCL,SiC) subsoil. May also correlate with some areas of Red River clay which exhibit stratification in the subsoil.
DCS	Dencross	Gleyed Rego Black	Emerson, Silty clay	The same as the dominant intermediately drained, Blackearth-Meadow associate of the Emerson, silty clay textural type. These soils generally have a clay substrate which underlies the silty deposits.

Table 12. - 2nd page of 6

Soil Symbol	Soil Name	Subgroup	Soil Association or Associate of the Morris Map Sheet, 1953.	Remarks
DNH	Denham	Orthic Black	Altona, clay substrate	The well drained, Blackearth associate of the Altona Association where a clay textured substrate occurs. Areas of Ah/Rc were delineated on the reconnaissance map.
DFS	Dufresne	Rego Humic Gleysol	Riverdale	The same as the poorly drained, Meadow soil in the recent alluvial deposits of the Riverdale Association.
DGS	Dugas	Gleyed Rego Black	Horndean Complex	A major inclusion in the Horndean Complex. The intermediately drained, Blackearth-Meadow associate, developed on the more mature Horndean soils having a lighter stratified (FSL) substrate.
EDK	Edkins	Rego Humic Gleysol	Altona	The poorly drained, Meadow associate of the Altona clay substrate.
EGF	Eigenhof	Orthic Black	Altona (heavy)	Equivalent to the representative well drained, Blackearth associate of the Altona heavy (FSCL,VFSCL) textural type.
EBG	Edenburg	Orthic Black	Altona (heavy)	A significant inclusion in the well drained, Blackearth associate of the Altona heavy with a sandy substrate.
GOO	Glenmoor	Rego Humic Gleysol	Emerson, silty clay	The poorly drained, Calcic Meadow associate of the Emerson Association, silty clay textural type.
GDH	Gnadenthal	Gleyed Rego Black	Altona	A significant inclusion in and the same as the intermediately drained, Blackearth-Meadow associate of the Altona very fine sandy loam grading to a very fine sandy clay loam.

Table 12. - 3rd page of 6

Soil Symbol	Soil Name	Subgroup	Soil Association or Associate of the Morris Map Sheet, 1953.	Remarks
GYV	Graysville	Gleyed Rego Black	Altona over Red River	The same as the Blackearth-Meadow associate of the Altona Association where a clay textured substrate occurs. Some areas of Ah/Rc were separated on the reconnaissance map.
GRA	Gretna	Gleyed Solonetzic Black	Horndean Complex	The same as the intermediately drained, Alkalinized (Solonetzic) associate of the Horndean Complex. These clayey soils have a stratified subsoil.
HHF	Hochfeld	Orthic Black	Altona (light)	A significant inclusion in the Altona fine sandy loam. The same as the representative well drained Blackearth associate.
HND	Horndean	Gleyed Black	Horndean Complex	A representative soil of the Horndean Complex. The intermediately drained, Blackearth-Meadow associate of the most mature Horndean soils with a lighter, stratified (FSL) substrate.
HIN	Hibsin	Orthic Black	Altona (light)	The same as the well drained, Blackearth associate of the Altona fine sandy loam to loamy fine sand with a clay textured substrate.
HDN	Hoddinott	Gleyed Black	Emerson (heavy)	A significant inclusion in and the same as the intermediately drained, Blackearth-Meadow associate of the Emerson silty clay.
JST	Jassett	Gleyed Black	Altona (light)	A minor inclusion in and the same as the imperfectly drained, Blackearth-Meadow associate of the Altona very fine sandy loam over fine sand to very fine sand in the Altona Association.

Table 12 - 4th page of 6

Soil Symbol	Soil Name	Subgroup	Soil Association or Associate of the Morris Map Sheet, 1953.	Remarks
JOD	Jordan	Orthic Black	Horndean Complex	A minor inclusion in the Horndean Complex. The well drained, Blackearth associate developed on the mature Horndean soils having a coarser stratified substrate.
KOT	Kronstal	Gleyed Black	Altona (light)	A minor inclusion in and the same as the imperfectly drained, Blackearth-Meadow associate of the Altona fine sandy loam.
LKD	Lakeland	Gleyed Rego Black	Emerson (light)	The same as the representative, imperfectly drained, Blackearth-Meadow associate of the Emerson silty clay loam.
LEW	Loewen	Rego Humic Gleysol	Riverdale	A minor inclusion in and the same as the poorly drained, Meadow soil on recent alluvium of the Riverdale Association.
MRS	Morris	Gleyed Solonetzic Black	Red River (Morris)	The intermediately drained, Alkalinized (Solonetzic) soil associate of the Red River Association. This soil is referred to as the Morris clay in the Morris Map Sheet.
MYT	Myrtle	Orthic Black	Red River	A significant inclusion in, and is the same as the well drained, Blackearth associate of the Red River Association.
NBG	Neuenberg	Gleyed Rego Black	Altona (light)	A major inclusion in the Altona Association. The imperfectly drained, Blackearth-Meadow associate of the Altona very fine sandy loam over fine sand to very fine sand.
NUH	Neuhorst	Gleyed Rego Black	Altona (heavy)	The dominant or representative, imperfectly drained, Blackearth-Meadow associate of the Altona very fine sandy clay loam.

Table 12 - 5th page of 6

Soil Symbol	Soil Name	Subgroup	Soil Association or Associate of the Morris Map Sheet, 1953.	Remarks
NWN	Newton Siding	Gleyed Rego Black	Altona (heavy)	The same as the intermediately drained, Blackearth-Meadow associate of the Altona heavy with a sandy substrate.
OWK	Osterwick	Rego Humic Gleysol	Altona (light)	A minor inclusion in and the same as the poorly drained, Meadow associate of the Altona fine sandy loam.
OBO	Osborne	Rego Humic Gleysol	Osborne	Equivalent to the Osborne soil which is the poorly drained, Meadow associate of the Red River Association.
PME	Plum Coulee	Gleyed Black	Horndean Complex	The intermediately drained, Blackearth-Meadow associate of the more mature Horndean soils with a stratified (SiCL,SiC) subsoil.
RLD	Reinland	Gleyed Rego Black	Altona (light)	A significant inclusion in and the same as the Blackearth-Meadow associate of the Altona fine sandy loam.
RFD	Reinfeld	Orthic Black	Altona	The same as the well drained, Blackearth associate of the Altona very fine sandy loam grading to a finer textured very fine sandy clay loam.
RGD	Rignold	Gleyed Black	Altona over Red River	The Blackearth-Meadow associate of the Altona Association where a clay textured substrate occurs (Ah/Rc).
RBK	Rosebank	Gleyed Rego Black	Altona (light)	A minor inclusion in and the same as the intermediately drained, Blackearth-Meadow associate of the Altona fine sandy loam to loamy fine sand with a clayey substrate.

Table 12 - 6th page of 6

Soil Symbol	Soil Name	Subgroup	Soil Association or Associate of the Morris Map Sheet, 1953.	Remarks
RSG	Rosengart	Orthic Black	Altona (light)	The well drained, Blackearth associate of the Altona very fine sandy loam over fine sand to very fine sand.
RWL	Rathwell	Gleyed Black	Altona (heavy)	A minor inclusion in and the same are the imperfectly drained, Blackearth-Meadow associate of the Altona very fine sandy clay loam.
RIV	Red River	Gleyed Rego Black	Red River	The dominant or representative soil of the Red River Association. The intermediately drained, Blackearth-Meadow associate (Red River clay).
SCY	Scanterbury	Gleyed Black	Red River	A significant inclusion in the imperfectly drained, Blackearth-Meadow associate of the Red River Association.
SRE	Seine River	Gleyed Cumulic Regosol	Riverdale	The same as the imperfectly drained, stratified, immature alluvial soil of the Riverdale Association. The dominant texture is silty clay.
WIK	Winkler	Orthic Black	Horndean Complex	The well drained, Blackearth associate of the more mature Horndean soils with a stratified (SiCL,SiC) subsoil. May also correlate with areas of well drained Red River clay which show evidence of stratification in the subsoil.

TABLE 13

Table 13. Correlation of Soil Names and Phase Symbols in the Morden-Winkler Report No. 18 with the Soil Symbols and Phase Notations in this Report (D76).

Symbol	Soil Name	Surface Texture	Phase	Symbol and phase notation in D76	
Ba	Birkenhead	Loamy sand		BKA	
Bb	Blumenfeld	Loam		BNF	
Bd	Blumengart	Clay		BMG	
Be	Blumenort	Clay		BUM	
Cal	Chortitz	Loam		CTZ	
Ca2	Chortitz	Loam	Gently undulating	CTZ/xcxx	
Da	Deadhorse	Clay		DHO	
Db	Deadhorse	Clay	Slightly saline	DHO/xxxs	
Dc	Deadhorse	Clay loam		DHO1	(variant)
Dd	Deadhorse	Clay loam	Slightly saline	DHO1/xxxs	
De	Deadhorse	Loam		DHO1	
Df	Dugas	Clay		DGS	
Dg	Dugas	Clay	Slightly saline	DGS/xxxs	
Dh	Dugas	Clay loam		DGS1	
Dk	Dugas	Loam		DGS1, GYV	(depending on depth)
D1	Dugas	Loam	Slightly saline	DGS1/xxxs	
Ec	Eigenhoff	Clay loam		EGF	
Ed	Edenburg	Clay loam		EBG	
Ga	Gnadenthal	Loam		GDH	
Gb	Gnadenthal	Loam	Slightly saline	GDH/xxxs	
Gc	Gnadenthal	Clay loam		GDH or NUH	
Gd	Gnadenthal	Clay		GDH2 (variant)	
Gf	Graysville	Loam		GYV	
Hb	Hochfeld	Fine sandy loam		HHF	
Hc	Hochfeld	Fine sandy loam	Eroded	HHF/1xxx	
Hd	Hochfeld	Fine sandy loam	Overblown	HHF/oxxx	
He	Horndean	Clay		HND	
Hf	Horndean	Clay loam		HND1	
Hh	Horndean	Loam		RGD or HND_1 (depending on depth)	
Hj	Hobson	Fine sandy loam		HIN (name changed to Hibsin)	
Ja	Jordan	Clay		JOD	
Jb	Jordan	Clay loam		JOD1	
Mo	Morris	Clay		MRS	
Na	Neuenberg	Very fine sandy loam		NBG	
Nc	Neuenberg	Loam		NBG	
Ne	Neuhorst	Clay loam		NUH	
Nf	Neuhorst	Clay loam	Slightly saline	NUH/xxxs	
Ng	Neuhorst	Loam		NUH	
Nh	Neuhorst	Clay		NUH2	
Nj	Newton Siding	Clay loam		NWN	
Nk	Newton Siding	Clay loam	Slightly saline	NWN/xxxs	
N1	Newton Siding	Clay		NWN2	
Nm	Newton Siding	Clay	Slightly saline	NWN2/xxxs	
Oa	Osterwick	Fine sandy loam		OWK	
Oc	Osborne	Clay		OBO	
Pa	Plum Coulee	Clay		PME	
Pb	Plum Coulee	Clay loam		PME1 (or RGD if CL is thick)	
Pc	Plum Coulee	Loam		PME1 (or RGD if loam is thick)	

Table 13. Correlation of Soil Names and Phase Symbols in the Morden-Winkler Report No. 18 with the Soil Symbols and Phase Notations in this Report (D76) (Cont'd).

Symbol	Soil Name	Surface Texture	Phase	Symbol and phase notation in D76
Ra	Reinland	Fine sandy loam		RLD
Rb	Reinland	Fine sandy loam	Eroded	RLD/1xxx
Rc	Reinland	Fine sandy loam	Overblown	RLD/oxxx
Rd	Reinland	Fine sandy loam		RLD
Re	Reinfeld	Loam		RFD
Rg	Rignold	Loam		RGD
Rj	Rosebank	Fine sandy loam		RBK
Rm	Rosengart	Loam		RSG
Rn	Rosengart	Very fine sandy loam		RSG
Rr	Red River	Clay		RIV
Wa	Winkler	Clay		WIK
Wb	Winkler	Clay loam		WIK1
Wc	Winkler	Loam		WIK1(or DNH if loam is thick)

APPENDIX B

GUIDES FOR EVALUATING SOIL SUITABILITY FOR SELECTED USES

Table 14 Land Classification Standards for Irrigation Suitability

Land Characteristics	Subclass		Class 1 - Very Good	Class 2 - Good	Class 3 - Fair	Class 4 - Poor
SOILS	S					
Texture						
very coarse textured		v	Fine sandy loams to	Loamy fine sand to	Sand to permeable	Gravel to
very fine textured		h	clay loams	light clay	clay	clay
Water holding capacity						
low available moisture capacity		q	40 to 60 sat. % >15cm storage in 1.2m <10cm/hr. hydraulic cond.	35 to 65 sat. % >12.5cm storage in 1.2m <12.5cm/hr. hydraulic cond.	25 to 75 sat. % >7.5cm storage in 1.2m <17.5cm/hr. hydraulic cond.	<25 or >75 sat. % <7.5cm storage in 1.2m >17.5cm/hr. hydraulic cond.
Geological Deposit						
shallow deposit over sand or gravel		k	.9m or more of fine sandy loam or heavier	.6m or more of fine sandy loam or heavier, or .75m plus of loamy fine sand or sandy loam	.5m or more of sandy loam or heavier, or .6m plus of loamy sand	<.5m of sandy loam or heavier, or .6m of loamy sand or sand
shallow deposit over impervious substrata		b	>3m of permeable material	>2m of permeable material	>1m of permeable material	<1m of permeable material
Salinity and Alkalinity[1,2]		a	<4 ms/cm in 0-.6m <8 ms/cm below .6m <6 S.A.R.	<4 ms/cm in 0-.6m <12 ms/cm below .6m <8 S.A.R.	<8 ms/cm in 0-.6m <15 ms/cm below .6m <12 S.A.R.	>8 ms/cm in 0-.6m >15 ms/cm below .6m >12 S.A.R.
EXTERNAL FEATURES						
Stones - rock clearing		r	None to light clearing	Light to medium clearing	Light to heavy clearing	Excessively stony
Topography	T	g	<1% and 0.1% in general gradient (0-3% slope)	<3% in general gradient (3-5% slope)	<5% in general gradient (5-10% slope)	>5% in general* gradient (>10% slope)**
Slope excess gradient						
DRAINAGE	D					
restricted outlet			No problem anticipated	Moderate drainage problem anticipated but may be improved at relatively low cost	Moderate to severe drainage problem anticipated but may be improved by expensive but feasible measures	Drainage improvement not considered feasible
water table			below 2.4m most of year	could be above 1.5m for a short period, then recedes to 2.4m or lower	within 1.5m most of year	within 1m most of year

* Criteria for gravity (flood) irrigation requirements.

** Estimated adjustments to slope criteria for overhead or sprinkler type irrigation methods.

[1] If sufficient gypsum is present in the soil, the S.A.R. may be lowered by leaching the soil (a very slow process), and the hydraulic conductivity may then improve.

[2] The degree of salinity may vary widely within short distances, and there may be no clear indication of the area occupied by each salinity class. Unless a very detailed mapping and sampling program is carried out, it is impossible to estimate the acreage occupied by each salinity class.

Table 15 Guide for assessing soil suitability as source of topsoil.

The term "topsoil" includes soil materials used to cover barren surfaces exposed during construction, and materials used to improve soil conditions on lawns, gardens, flower beds, etc. The factors to be considered include not only the characteristics of the soil itself, but also the ease or difficulty of excavation, and where removal of topsoil is involved, accessibility to the site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
i	Flooding	None	May flood occasionally for short periods	Frequent flooding	Constantly flooded
w	Wetness[2]	Wetness is not determining if better than very poorly drained.			Very poorly drained and permanently wet soils
t	Slope	0-5%	5-9%	9-15%	>15%
p	Stoniness[2]	Stones 10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones 0.1 m apart (Class 5)
c	Coarse fragments[2]: percent, by volume	<3%	3-15%	15-35%	>35%
s	Texture[2]	FSL, VFSL, L, SiL, SL, SC if 1:1 clay is dominant	CL, SCL, SiCL, SC if 2:1 clay is dominant; c and sic if 1:1 clay is dominant	S, LS, C and SiC if 2:1 clay is dominant. organic soils[3]	Marl, diatomaceous earth
b	Depth of Topsoil[4]	>40 cm	15-40 cm	8-15 cm	<8 cm
n	Salinity of Topsoil[5]	E.C. 0-1	E.C. 1-4	E.C. 4-8	E.C. >8

[1] The symbols are used to indicate the nature of the limitation.

[2] For an explanation of texture, consistence, stoniness, coarse fragments and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Non-woody organic materials are assessed as good sources for topsoil if mixed with or incorporated into mineral soil.

[4] The remaining soil material (at least 8 cm) must be reclaimable after the uppermost soil is removed.

[5] E.C. = Electrical Conductivity (millisiemens/cm).

Table 16 Guide for assessing soil suitability as source of sand and gravel.

The purpose of this table is to provide guidance for assessing the probable supply as well as quality of the sand or gravel for use as road base material and in concrete. The interpretation pertains mainly to the characteristics of the soil substratum to a depth of 150 cm, augmented by observations made in deep cuts as well as geological knowledge where available.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	Unified Soil Group	SW SP GW GP	SW-SM SP-SM GP-GM GW-GM	SM SW-SC SP-SC GM GP-GC GW-GC	All other groups and bedrock
h	Depth to Seasonal Water Table	Not class determining if deeper than 50 cm		50 cm	
q	Depth to Sand and Gravel	<25 cm	25-75 cm[2]	>75 cm[2]	
p	Stoniness[3]	Not class determining if stones >.5 m apart (Class 0, 1, 2 and 3)		Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
d	Depth to Bedrock	>100 cm	50-100 cm	<50 cm	

[1] The symbols are used to indicate the nature of the limitation.

[2] Rated good if it is known that the underlying gravel or sand deposit is thick (>100 cm).

[3] For an explanation of stoniness and rockiness, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

Table 17 Guide for assessing soil suitability as source of roadfill.

Fill material for buildings or roads are included in this use. The performance of the material when removed from its original location and placed under load at the building site or road bed are to be considered. Since surface materials are generally removed during road or building construction their properties are disregarded. Aside from this layer, the whole soil to a depth of 150-200 cm should be evaluated. Soil materials which are suitable for fill can be considered equally suited for road subgrade construction.

Symbol[1]	Items Affecting Use[2]	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	Subgrade[3]				
	a. AASHO group index[4]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[5] and SC[5]	CL (with P.I.[6] <15) and ML	CL (with P.I.[6] of 15 or more), CH and MH[7]	OL, OH and Pt
l	Shrink-swell potential	Low	Moderate	High	
f	Susceptibility to frost action[8]	Low	Moderate	High	
t	Slope	0-15%	15-30%	30-45%	>45%
p	Stoniness[9]	Stones >2 m apart (Class 0, 1 and 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[9]	Rock exposures >35 m apart and cover <10% of the surface	Rock exposure 10-35 m apart and cover 10-25% of the surface	Rock exposure 3.5-10 m apart and cover 25-50% of the surface	Rock exposures <3.5 m apart and cover 50-90% of the surface
w	Wetness[9]	Excessively drained to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
d	Depth to Bedrock	>100 cm	50-100 cm	20-50 cm	<20 cm
h	Depth to Seasonal Water Table	>150 cm	75-150 cm	50-75 cm	<50 cm

1/ The symbols are used to indicate the nature of the limitation.

2/ The first three items pertain to soil after it is placed in a fill; the last six items pertain to soil in its natural condition before excavation for road fill.

3/ This item estimates the strength of the soil material, that is, its ability to withstand applied loads.

4/ Use AASHO group index only where laboratory data are available for the kind of soil being rated; otherwise, use Unified soil groups.

5/ Downgrade suitability rating to fair if content of fines is more than about 30 percent.

6/ P.I. means plasticity index.

7/ Upgrade suitability rating to fair if MH is largely kaolinitic, friable, and free of mica.

8/ Use this item only where frost penetrates below the paved or hardened surface layer and where moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front.

9/ For an explanation of stoniness, rockiness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

Table 18 Guide for assessing soil suitability for permanent buildings.

This guide applies to undisturbed soils to be evaluated for single-family dwellings and other structures with similar foundation requirements. The emphasis for rating soils for buildings is on foundation requirements; but soil slope, susceptibility to flooding and other hydrologic conditions, such as wetness, that have effects beyond those related exclusively to foundations are considered too. Also considered are soil properties, particularly depth to bedrock, which influence excavation and construction costs for the building itself and for the installation of utility lines. Excluded are limitations for soil corosivity, landscaping and septic tank absorption fields.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability[3]			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[4]	With Basements: Very rapidly, rapidly and well drained. Without Basements: Very rapidly, rapidly, well and moderately well drained.	With Basements: Moderately well drained. Without Basements: Imperfectly drained.	With Basements: Imperfectly, poorly, and very poorly drained. Without Basements: Poorly and very poorly drained.	With Basements: Permanently wet soils. Without Basements: Permanently wet soils.
h	Depth to Seasonal Water Table	With Basements: >150 cm Without Basements: >75 cm	With Basements: 75-150 cm Without Basements: 50-75 cm	With Basements: 25-75 cm Without Basements: 25-50 cm	With Basements: <25 cm Without Basements: <25 cm
i	Flooding	None	None	Occasional flooding (once in 5 years)	Frequent flooding (every year)
t	Slope[5]	0-9%	9-15%	15-30%	>30%
a	Subgrade[6]				
	a. AASHO group index[7]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM and GC and SC	CL (with P.I.[8] <15) and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	Potential Frost Action[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[4]	Stones >10 m apart (Class 0 to 1)	Stones 2-10 m apart (Class 2[10])	Stones 0.1-2 m apart (Class 3[10] to 4)	Stones <0.1 m apart (Class 5[10])
r	Rockiness[4],[11]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to allow location of permanent buildings
d	Depth to Bedrock[11]	With Basements: >150 cm Without Basements: >100 cm	With Basements: 100-150 cm Without Basements: 50-100 cm	With Basements: 50-100 cm Without Basements: <50 cm	With Basements: <50 cm

1/ By halving the slope limits, this table can be used for evaluating soil suitability for buildings with large floor areas, but with foundation requirements not exceeding those of ordinary three-storey dwellings.

2/ The symbols are used to indicate the nature of the limitation.

3/ Some soils assessed as fair or poor may be good sites from an aesthetic or use standpoint, but they will require more site preparation and/or maintenance.

4/ For an explanation of rockiness, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Reduce the slope limits by one half for those soils subject to hillside slippage.

6/ This item estimates the strength of the soil, that is, its ability to withstand applied loads. When available, AASHO Group Index values from laboratory tests were used; otherwise the estimated Unified classes were used.

7/ Group index values were estimated from information published by the Portland Cement Association (PCA, 1962), pp. 23-25.

8/ P.I. means plasticity index.

9/ Frost heave only applies where frost penetrates to the assumed depth of the footings and the soil is moist. The potential frost action classes are taken from the United States Army Corps of Engineers (1962), pp. 5-8.

10/ Rate one class better for buildings without basements.

11/ Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment such as backhoes.

Table 19 Guide for assessing soil suitability for local roads and streets.

This guide applies to soils to be evaluated for construction and maintenance of local roads and streets. These are improved roads and streets having some kind of all-weather surfacing, commonly asphalt or concrete, and are expected to carry automobile traffic all year. They consist of: (1) the underlying local soil material (either cut or fill) called the subgrade; (2) the base material of gravel, crushed rock, or lime or soil cement stabilized soil called the subbase; and (3) the actual road surface or pavement, either flexible or rigid. They also are graded to shed water and have ordinary provisions for drainage. With the probable exception of the hardened surface layer, the roads and streets are built mainly from the soil at hand, and cuts and fills are limited, usually less than 2 meters. Excluded from consideration in this guide are highways designed for fast-moving, heavy trucks.

Properties that affect design and construction of roads and streets are: (1) those that affect the load supporting capacity and stability of the subgrade, and (2) those that affect the workability and amount of cut and fill. The AASHO and Unified Classification give an indication of the traffic supporting capacity. Wetness and flooding affect stability. Slope, depth of hardrock, stoniness, rockiness, and wetness affect the ease of excavation and the amount of cut and fill to reach an even grade.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[3]	Very rapidly, rapidly, well and moderately well drained	Imperfectly drained	Poorly and very poorly drained	Permanently wet soils
i	Flooding	None	Infrequent (once in 5 years)	Occasional (once in 2-4 years)	Frequent (every year)
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Bedrock[4]	>100 cm	50-100 cm	<50 cm	
a	Subgrade[5]				
	a. AASHO group index[6]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[7] and SC[7]	CL (with P.I.[8] <15) and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	Susceptibility to Frost Heave[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[3]	Stones >2 m apart (Class 0 to 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[3]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to permit location of roads and streets

1/ These guidelines, with some adjustment of slope and rockiness limits, will also be useful for assessing soils for use as parking lots.

2/ Symbols are used to indicate the nature of the limitation.

3/ For an explanation of stoniness, rockiness and soil drainage classes, see the Canada Soil Information System (Canada Soil Survey Committee, 1978).

4/ Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery.

5/ This item estimates the strength of soil materials as it applies to roadbeds. When available, AASHO Group Index values from laboratory tests were used; otherwise, the estimated Unified classes were used. The limitations were estimated assuming that the roads would be surfaced. On unsurfaced roads, rapidly drained, very sandy, poorly graded soils may cause washboard or rough roads.

6/ Group index values were estimated from information published by the Portland Cement Association (PCA, 1962) pp. 23-25.

7/ Downgrade to moderate if content of fines (less than 200 mesh) is greater than about 30 percent.

8/ P.I. means plasticity index.

9/ Frost heave is important where frost penetrates below the paved or hardened surface layer and moisture transportable by capillary movement is sufficient to form ice lenses at the freezing point. The susceptibility classes are taken from the United States Army Corps of Engineers (1962) pp. 5-8.

Table 20 Guide for assessing soil suitability for trench-type sanitary landfills.

The trench-type sanitary landfill is a sanitary landfill, in which dry garbage and trash is buried daily in an open trench and covered with a layer of soil material. Suitability of the site is dependent upon the potential for pollution of water sources through groundwater contact with the refuse, or leachate arising from the site. Those properties affecting ease of excavation of the site must be supplemented with geological and hydrological knowledge to provide subsurface soil and groundwater data to a depth of at least 3 to 4.5 m, a common depth of landfills.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability			
		Good - G[3]	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal High Water Table	Not class determining if more than 180 cm		100-180 cm	<100 cm
w	Wetness[4]	Not class determining if better than imperfectly drained		Imperfectly drained	Poorly and very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[5]	<5 cm/hr	<5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-15%	15-30%	30-45%	>45%
s	Soil Texture[4],[6] (dominant to a depth of 150 cm)	SL, L, SiL, SCL	SiCL[7], CL, SC, LS	SiC, C	Muck, peat, gravel, sand
d	Depth to Hard Bedrock Rippable	>150 cm >150 cm	>150 cm 100-150 cm	100-150 cm 100-150 cm	<100 cm <100 cm
p	Stoniness[4]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones <0.1 m apart (Class 5)
r	Nature of Bedrock	Impermeable			Highly permeable, fractured, easily soluble

1/ Based on soil depth (120 cm) commonly investigated in making soil surveys.

2/ The symbols are used to indicate the nature of the limitation.

3/ If probability is high that the soil material to a depth of 3 to 4.5 m will not alter a rating of good or fair, indicate this by an appropriate footnote, such as "Probably good to a depth of 3.5 m", or "Probably fair to a depth of 3.5 m".

4/ For an explanation of stoniness, texture and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Reflects ability of soil to retard movement of leachate from the landfills; may not reflect a limitation in arid and semiarid areas.

6/ Reflects ease of digging and moving (workability) and trafficability in the immediate area of the trench where there may not be surfaced roads.

7/ Soils high in expansive clays may need to be given a suitability rating of poor.

Table 21 Guide for assessing soil suitability for area-type sanitary landfills.

In the area-type sanitary landfill refuse is placed on the surface of the soil in successive layers. The daily and final cover material generally must be imported. A final cover of soil material at least 60 cm thick is placed over the fill when it is completed.

The soil under the proposed site should be investigated so as to determine the probability that leachates from the landfill can penetrate the soil and thereby pollute water supplies.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal Water Table[2]	>150 cm	150-100 cm	50-100 cm	<50 cm
w	Wetness[2],[3]	Rapid to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[4],[5]	Not class determining	if less than 5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-9%	9-15%	15-30%	>30%

[1] The symbols are used to indicate the nature of the limitation.

[2] Reflects influence of wetness on operation of equipment.

[3] For an explanation of drainage, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[4] Reflects ability of the soil to retard movement of leachate from landfills; may not reflect a limitation in arid and semiarid areas.

[5] Due to possible groundwater contamination, impermeable bedrock is considered poor and permeable bedrock is rated very poor for area-type sanitary landfills.

Table 22 Guide for assessing soil suitability as cover material for area-type sanitary landfills.

The term cover material includes soil materials used to put a daily and final covering layer on refuse in area-type sanitary landfills. This cover material may be derived from the area of the landfill or may be brought in from surrounding areas.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
s	Texture[2],[3]	SL, L, SiL, SCL	SiCL, CL, SC, LS	SiC, C	Muck, peat, sand, gravel
d	Depth to bedrock[4]	>150 cm	100-150 cm	50-100 cm	<50 cm
c	Coarse fragments[2]	<15%	15-35%	>35%	
p	Stoniness[2]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones <0.1 m apart (Class 5)
t	Slope	<9%	9-15%	15-30%	>30%
w	Wetness[2]	Not class determining if better than poorly drained		Poorly drained	Very poorly drained or permanently wet soils

1/ The symbols are used to indicate the nature of the limitation.

2/ For an explanation of consistence, texture, coarse fragments, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

3/ Soils having a high proportion of non-expansive clays may be given a suitability rating one class better than is shown for them in this table.

4/ Thickness of material excluding topsoil, which will be stockpiled (see guide for topsoil).

Table 23 Guide for assessing soil suitability for reservoirs and sewage lagoons.

Factors affecting the ability of undisturbed soils to impound water or sewage and prevent seepage are considered for evaluating soils on their suitability for reservoir and lagoon areas. This evaluation considers soil both as a vessel for the impounded area and as material for the enclosing embankment. As the impounded liquids could be potential sources of contamination of nearby water supplies, e.g. sewage lagoons, the landscape position of the reservoir as it affects risk of flooding must also be considered.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Water Table[2]	>150 cm	100-150 cm	50-100 cm	<50 cm
i	Flooding[3]	None	None	Subject to infrequent flooding (once in 50 years)	Subject to frequent high level flooding
k	Soil Permeability	0-0.5 cm/hr	0.5-5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-2%	2-5%	5-9%	>9%
o	Organic Matter	<2%	2-10%	10-30%	>30%
c	Coarse Fragments[4] <25 cm in diameter, % by volume	<20%	20-35%	>35%	
p	Stoniness[4], >25 cm diameter, percent of surface area	<3% (Class 0, 1 and 2)	3-15% (Class 3)	15-50% (Class 4)	>50% (Class 5)
d	Depth to Bedrock[5]	>150 cm	100-150 cm	50-100 cm	<50 cm
j	Thickness of Slowly Permeable Layer	>100 cm	50-100 cm	50-25 cm	<25 cm
a	Subgrade Unified Soil Classes	GC, SC, CL, & CH	GM, ML, SM & MH	SW & SP	OL, OH & Pt GP, GW

1/ The symbols are used to indicate the nature of the limitation.

2/ If the floor of the lagoon has nearly impermeable material at least 50 cm thick, disregard depth to water table.

3/ Disregard flooding if it is not likely to enter or damage the lagoon (flood waters have low velocity and depth less than 150 cm).

4/ For an explanation of coarse fragments and stoniness classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Surface exposures of non rippable rock are rated very poor. If underlying bedrock is impermeable, rating should be one class better.

Table 24 Guide for assessing soil suitability for septic tank absorption fields.

This guide applies to soils to be used as an absorption and filtering medium for effluent from septic tank systems. A subsurface tile system laid in such a way that effluent from the septic tank is distributed reasonably uniformly into the natural soil is assumed when applying this guide. A rating of poor need not mean that a septic system should not be installed in the given soil, but rather, may suggest the difficulty, in terms of installation and maintenance, which can be expected.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
k	Permeability[2]	Rapid to moderately rapid	Moderate	Slow	Very slow
	Percolation Rate[3] (Auger hole method)	About 8-18 min/cm[3]	18-24 min/cm	Slower than 24 min/cm	
h	Depth to Seasonal Water Table[4]	>150 cm[5]	100-150 cm	50-100 cm	<50 cm
i	Flooding	Not subject to flooding	Not subject to flooding	Subject to occasional flooding (once in 5 years)	Floods every year
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Hard Rock, bedrock or other impervious materials	>150 cm	100-150 cm[6]	50-100 cm	<50 cm

1/ The symbols are used to indicate the nature of the limitation.

2/ The suitability ratings should be related to the permeability of soil layers at and below depth of the tile line.

3/ Soils having a percolation rate less than about 8 min/cm are likely to present a pollution hazard to adjacent waters. This hazard must be noted, but the degree of hazard must, in each case, be assessed by examining the proximity of the proposed installation to water bodies, water table, and related features. The symbol g is used to indicate this condition. Refer to U.S. Dept. of Health, Education and Welfare (1969) for details of this procedure.

4/ Seasonal means for more than one month. It may, with caution, be possible to make some adjustment for the severity of a water table limitation in those cases where seasonal use of the facility does not coincide with the period of high water table.

5/ A seasonal water table should be at least 100 cm below the bottom of the trench at all times for soils rated Good (U.S. Dept. of Health, Education and Welfare, 1969). The depths used to water table are based on an assumed tile depth of 50 cm. Where relief permits, the effective depth above a water table or rock can be increased by adding appropriate amounts of fill.

6/ Where the slope is greater than 9%, a depth to bedrock of 100-150 cm is assessed as poor.

Table 25 Guide for assessing soil suitability for playgrounds.

This guide applies to soils to be used intensively for playgrounds for baseball, football, badminton, and for other similar organized games. These areas are subject to intensive foot traffic. A nearly level surface, good drainage, and a soil texture and consistence that gives a firm surface generally are required. The most desirable soils are free of rock outcrops and coarse fragments.

Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Rapidly, well and moderately well drained soils with no ponding or seepage. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding of short duration and imperfectly drained soils. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding, and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	Occasional flooding. May flood once every 2-3 years during season of use.	Floods every year during season of use.	Prolonged flooding during season of use.
k	Permeability	Very rapid to moderate.	Moderately slow and slow.	Very slow.	
t	Slope	0-2%	2-5%	5-9%	>9%
d	Depth to Bedrock	>100 cm	50-100 cm[3]	<50 cm[3]	
c	Coarse fragments on surface[2]	Relatively free of coarse fragments.	<20% coarse fragments.	>20% coarse fragments.	
p	Stoniness[2]	Stones >10 m apart. (Class 0 to 1)	Stones 2-10 m apart. (Class 2)	Stones 0.1-2 m apart. (Class 3, 4)	Stones <0.1 m apart. (Class 5)
r	Rockiness[2]	Rock exposures >100 m apart and cover <2% of the surface.	Rock exposures 30-100 m apart and cover about 2-10% of the surface.	Rock exposures <30 m apart and cover >10% of the surface.	Rock outcrops too frequent to permit playground location.
s	Surface Soil Texture[2],[4]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS	SC, SiC, C[5]; S, Si	Peaty soils; S and LS subject to blowing.
q	Depth to Sand or Gravel[6]	>100 cm	50-100 cm	<50 cm	
m	Useful Moisture[7]	Water storage capacity[8] >15.0 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

1/ The symbols are used to indicate the nature of the limitation.

2/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).
Coarse fragments for the purpose of this table include gravels and cobbles.

3/ Downgrade to a very poor suitability rating if the slope is greater than 5%.

4/ Surface soil texture influences soil ratings as it affects foot trafficability, surface wetness, dust, and maintenance. Adverse soil textures may be partially or completely overcome with the addition of topsoil.

5/ Moderately well and well drained SC, SiC and C soils may be rated fair.

6/ Depth to sand or gravel is considered a limitation in that levelling operations may expose sand or gravel, thereby bringing about adverse surface textures and undesirable amounts of coarse fragments. The addition of topsoil after the levelling process would overcome this limitation.

7/ This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

8/ Consult glossary for definitions of terms used.

Table 26 Guide for assessing soil suitability for picnic areas.

This guide applies to soils considered for intensive use as park-type picnic areas. It is assumed that most vehicular traffic will be confined to the access roads. Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils not subject to seepage or ponding. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils not subject to ponding or seepage. Water Table above 50 cm for short periods during season of use.	Imperfectly drained soils subject to seepage or ponding. Poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	May flood 1 or 2 times per year for short periods during season of use.	Floods more than 2 times during season of use.	Prolonged flooding during season of use.
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[2],[3]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2]	0-20%	20-50%	>50%	
p	Stoniness[2]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[2],[5],[6]	Rock exposures roughly 30-100 or more m apart and cover <10% of the surface.	Rock exposures roughly 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of picnic areas.
m	Useful Moisture[7]	Water storage capacity[8] >15 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978). Coarse fragments for the purpose of this table, include gravels and cobbles. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

[3] Surface soil texture influences soil ratings as it affects foot trafficability, dust and soil permeability.

[4] Moderately well and well drained SC, SiC and C soils may be rated fair.

[5] Very shallow soils are rated as having severe or very severe limitations for stoniness or rockiness.

[6] The nature and topography of the bedrock exposures may significantly alter these ratings. As such, on-site investigations will be necessary in map units containing bedrock when these are considered as possible sites.

[7] This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

[8] Consult glossary for definitions of terms used.

Table 27 Guide for assessing soil suitability for camp area.

This guide applies to soils to be used intensively for tents and camp trailers and the accompanying activities of outdoor living. It is assumed that little site preparation will be done other than shaping and levelling for campsites and parking areas. The soil should be suitable for heavy foot traffic by humans and limited vehicular traffic. Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of site.

Back country campsites differ in design, setting and management but require similar soil attributes. These guides should apply to evaluations for back country campsites but depending on the nature of the facility the interpreter may wish to adjust the criteria defining a given degree of limitation to reflect the changed requirement. For example, small tentsites may allow rock exposures greater than 10 m apart to be considered a slight limitation.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils with no seepage or ponding. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils with no seepage or ponding. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None	Very occasional flooding during season of use. Once in 5-10 years.	Occasional flooding during season of use. Once in 2-4 years.	Flooding during every season of use.
k	Permeability	Very rapid to moderate inclusive.	Moderately slow and slow.	Very slow.	
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[2,3]	SL, FSL, VFSL, L	SiL, SCL, CL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2,5]	0-20%	20-50%	>50%	
p	Stoniness[2,6]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
r	Rockiness[2,6]	No rock exposures	Rock exposures >10 m apart and cover <25% of the area.	Rock exposures <10 m apart and cover >25% of the area.	Rock exposures too frequent to permit campground location.

[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Surface soil texture influences soil ratings as it affects foot trafficability, dust, and soil permeability.

[4] Moderately well and well drained SC, SiC and C soils may be rated fair.

[5] Coarse fragments for the purpose of this table include gravels and cobbles. Some gravelly soils may be rated as having slight limitations if the content of gravel exceeds 20% by only a small margin, providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

[6] Very shallow soils are rated as having a limitation for rockiness and/or stoniness.

Table 28 Guide for assessing soil suitability for paths and trails.

It is assumed that the trails will be built at least 45 cm wide and that obstructions such as cobbles and stones will be removed during construction. It is also assumed that a dry, stable tread is desirable and that muddy, dusty, worn or eroded trail treads are undesirable. Hiking and riding trails are not treated separately, but as the design requirements for riding trails are more stringent, a given limitation will be more difficult to overcome. Poor or very poor suitability does not indicate that a trail cannot or should not be built. It does, however, suggest higher design requirements and maintenance to overcome the limitations.

Symbol[1]	Items[2] Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	Texture[3],[4]	SL, FSL, VFSL, LS, L	SiL, CL, SiCL, SCL	SC, SiC, C[5]; Sand, Si	Peaty soils; loose sand subject to blowing
c	Coarse Fragment Content[4],[6]	0-20%	20-50%	>50%	
p	Stoniness[4]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
w	Wetness[4]	Very rapidly, rapidly well, and moderately well drained soils. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage and ponding and imperfectly drained soils. Water table may be above 50 cm for short periods during season of use.	Poorly and very poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Permanently wet soils.
r	Rockiness[4],[7]	Rock exposures >30 m apart and cover <10% of the surface.	Rock exposures 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of paths and trails.
t	Slope[8]	0-15%	15-30%	30-60%	>60%
i	Flooding	Not subject to flooding during season of use.	Floods 1 or 2 times during season of use.	Floods more than 2 times during season of use.	Subject to prolonged flooding during season of use.

[1] The symbols are used to indicate the nature of the limitation.

[2] The items affecting use listed in this table are those which have been shown to cause significant differences in trail response. Elevation, aspect, position on slope, and snow avalanching may have slight affects or influence trail management and should be considered in the final site evaluation. Items such as vegetation, fauna, and scenic value are not considered in the guidelines (Epp, 1977).

[3] Texture refers to the soil texture which will form the tread texture. This is the surface texture on level areas but may be a subsurface texture on slopes. Textural classes are based on the less than 2 mm soil fraction. Texture influences soil ratings as it influences foot trafficability, dust, design or maintenance of trails, and erosion hazards.

[4] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Moderately well and well drained SC, SiC and C soils may be rated fair.

[6] Coarse fragments for the purpose of this table, include gravels and cobbles. Gravels tend to cause unstable footing when present in high amounts, and are also associated with increased erosion. Cobbles (and stones) must be removed from the trail tread, increasing construction and maintenance difficulties. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix or (b) the fragments are less than 2 cm in size.

[7] The type of rock outcrop (flat lying vs cliffs), and the orientation of the structure (linear cliffs vs massive blocks) can greatly alter the degree of the limitation. Each site with a Rockiness limitation based on the percent rock outcrop above should be evaluated on its own merits and the degree of limitation should then be modified appropriately if necessary.

[8] Slope in this context refers to the slope of the ground surface, not the slope of the tread.

APPENDIX C

GLOSSARY

AASHO classification (soil engineering) - The official classification of soil materials and soil aggregate mixtures for highway construction used by the American Association of State Highway Officials.

Acid soil - A soil having a pH less than 7. See pH and Reaction, soil.

Alkaline soil - A soil having a pH greater than 7. See Reaction, soil.

Alluvium - A general term for all deposits of rivers and streams.

Arable soil - Soil suitable for plowing and cultivation.

Association - A sequence of soils of about the same age, derived from similar parent material, and occurring under similar climatic conditions but showing different characteristics due to variations in relief and in drainage.

1/3 Atmosphere Moisture - The moisture percentage on dry weight basis of a soil sample that has been air dried, screened, saturated and subjected to a soil moisture tension of 345 cm of water through a permeable membrane for a period of 48 hours. It approximates the soil moisture retention capacity.

Available nutrient - That portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

Available soil moisture - The portion of water in a soil that can be readily absorbed by plant roots: generally considered to be that water held in the soil up to approximately 15 atmospheres pressure.

Bearing capacity - Capacity of soil (in moist to wet conditions) to support loads such as buildings, people, vehicles, and animals.

Bedrock - The solid rock that underlies soil and regolith or that is exposed at the surface.

Boulders - Stones which are larger than 60 cm in diameter.

Bulk density - The weight of oven dry soil (105 degrees C) divided by its volume at field moisture conditions, expressed in grams per cubic centimeter.

Buried soil - Soil covered by an alluvial, loessial, or other deposit, usually to a depth greater than the thickness of the solum.

Calcareous soil - Soil containing sufficient calcium carbonate (often with magnesium carbonate) to effervesce visibly when treated with hydrochloric acid.

Calcium Carbonate Equivalent - Refers to the percent of carbonates in the soil expressed on the basis of calcium carbonate. Terms used to express the carbonate contents of soils are:

noncalcareous	<1%
weakly calcareous	1-5%
moderately calcareous	6-15%
strongly calcareous	16-25%
v. strongly calcareous	26-40%
extremely calcareous	>40%

Capillary fringe - A zone of essentially saturated soil just above the water table. The size distribution of the pores determines the extent and degree of the capillary fringe.

Carbon-nitrogen ratio (C/N ratio) -The ratio of the weight of organic carbon to the weight of total nitrogen in a soil or in an organic material.

Cation Exchange Capacity (CEC) - A measure of the total amount of exchangeable cations that can be held by a soil. Expressed in milliequivalents per 100g of soil.

Clay - As a soil separate, the mineral soil particles less than 0.002 mm in diameter: usually consisting largely of clay minerals. As a soil textural class, soil materials that contain 40 or more percent clay, less than 45 percent sand and less than 40 percent silt.

Cobbles - Rock fragments 8 to 25 cm in diameter.

Color - Soil colors are compared with a Munsell color chart. The Munsell system specifies the relative degrees of the three simple variables of color: hue, value and chroma. For example: 10YR 6/4 means a hue of 10YR, a value of 6, and a chroma of 4.

Complex (soil) - A mapping unit used in detailed and reconnaissance soil surveys where two or more soil series that are so intimately intermixed in an area that it is impractical to separate them at the scale of mapping used.

Concretions - Hard grains, pellets or nodules from concentration of compounds in the soil that cement soil grains together.

Conductivity, electrical - A physical quantity that measures the readiness with which a medium (irrigation water and soil extracts) transmits electricity. It ex-presses the concentration of salt in terms of the conductance (reciprocal of the electric resistance in ohms) in milliSiemens per cm (or expressed as deciSiemens per meter - dS/m).

Consistence (soil) - The mutual attraction of the particles in a soil mass, or their resistance to separation or deformation. It is described in terms such as loose, soft, friable, firm, hard, sticky, plastic or cemented.

Consumptive use factor (CU) - The ratio of consumptive use of water by a crop to potential evapotranspiration and transpiration. An actively growing crop that completely covers the soil over a large area and that has an ample supply of readily available soil water has a consumptive use factor of 1.0.

Consumptive use of water - The sum of the depths of water transpired by the plants and evaporated from the soil surface and from intercepted precipitation. It may be less or greater than potential evapotranspiration.

Contour - An imaginary line connecting points of equal elevation on the surface of the soil.

Cover - This term generally has one of the following meanings:

1. Vegetation or other material providing protection
2. In forestry, low growing shrubs and herbaceous plants under trees (i.e., ground cover vs. tree cover)
3. Any vegetation producing a protective mat on or just above the soil surface.

Creep (soil) - Slow mass movement of soil and soil material down rather steep slopes primarily under the influence of gravity, but aided by saturation with water and by alternate freezing and thawing.

Decile portion - A one-tenth portion. As used in the soil map symbol A7-B3 means that the A soils cover seven tenths and the B soils cover three tenths of the map unit.

Delta - A fluvial or glaciofluvial fan shaped deposit at the mouth of a river that empties into a lake or sea.

Deflocculate - To separate or to break up soil aggregates into individual particles by chemical or physical means or both.

Degradation (of soils) - The changing of a soil to a more highly leached and more highly weathered condition, usually accompanied by morphological changes such as the development of an eluviated light colored (Ae) horizon.

Dispersion - Is rated high, moderate or low depending on how readily the soil structure breaks down or slakes because of excess moisture. A rating of high indicates that soil aggregates slake readily;
a rating of low indicates that aggregates are resistant to dispersion and remain clumped together.

Drainage (soil) - (1) The rapidity and extent of the removal of water from the soil by runoff and flow through the soil to underground spaces. (2) As a condition of the soil, it refers to the frequency and duration of periods when the soil is free of saturation.

Drainage in soil reports is described on the basis of actual moisture content in excess of field capacity and length of the saturation period within the plant root zone. The terms are as follows:

Very rapidly drained - Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very rapidly if

underlying material is pervious. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Soils have very low available water storage capacity (usually less than 2.5 cm) within the control section and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Rapidly drained - Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Soils have low available water storage capacity (2.5-4 cm) within the control section, and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Well drained - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity (4-5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes subsurface flow may occur for short durations but additions are equalled by losses. These soils are usually free of mottles within 100 cm of the surface but may be mottled below this depth. Soil horizons are usually bright colored.

Moderately well drained - Water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient, or some combination of these. Soils have intermediate to high water storage capacity (5-6cm) within the control section and are usually medium to fine in texture. Soils are commonly mottled in the 50 to 100 cm depth. Colors are dull brown in the subsoil with stains and mottles.

Imperfectly drained - Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is major supply. If subsurface water or groundwater, or both, is the main source, flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high; contribution by subsurface flow or groundwater flow, or both, increases as available water storage capacity decreases. Soils have a wide range in available water supply, texture, and depth, and are gleyed phases of well drained subgroups. These soils generally have mottling below the surface layers and generally have duller colors with depth, generally brownish gray with mottles of yellow and gray.

Poorly drained - Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface flow or groundwater flow, or both, in addition to precipitation are main water sources; there may also be a perched water table, with precipitation exceeding evapotranspiration. Poorly drained soils have a wide range in available water storage capacity, texture, and depth, and are gleyed subgroups, Gleysols, and Organic soils.

Very poorly drained - Water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen. Excess water is present in the soil for the greater part of the time. Groundwater flow and subsurface flow are major water sources. Precipitation is less important except where there is a perched water table with precipitation exceeding evapotranspiration. These soils have a wide range in available water storage capacity, texture, and depth, and are either Gleysolic or Organic.

Dryland farming - The practice of crop production in low rainfall areas without irrigation.

Eluvial horizon - A horizon from which material has been removed in solution or in water suspension.

Eolian - Soil material accumulated through wind action.

Erosion - The wearing away of the land surface by detachment and transport of soil and rock material through the action of moving water, wind or other geological processes. The ratings of erosion are:

Erosion 1 slightly eroded - soil with a sufficient amount of the A

horizon removed that ordinary tillage will bring up and mix the B horizon or other lower lying horizons with surface soil in the plow layer.

Erosion 2 — moderately eroded - soil with all of the A horizon and a part of the B or other lower lying horizons removed. The plow layer consists mainly of the original horizons below the A or below the original plow layer.

Erosion 3 — severely eroded - soils have practically all of the original surface soil removed. The plow layer consists mainly of C horizon material, especially on knolls and steep upper slope positions.

Evapotranspiration - The combined loss of water from a given area, and during a specific period of time, by evaporation from the soil surface and transpiration from plants.

Field Moisture Equivalent - The minimum moisture content at which a drop of water placed on a smoothed surface of the soil will not be absorbed immediately by the soil, but will spread out over the surface and give it a shiny appearance.

Flood plain - The land bordering a stream, built up of sediments from overflow of the stream and subject to inundation when the stream is at flood stage.

Fluvial deposits - All sediments past and present, deposited by flowing water, including glaciofluvial deposits.

Frost heave - The raising of the surface caused by ice in the subsoil.

Friable - Soil aggregates that are soft and easily crushed between thumb and forefinger.

Glaciofluvial deposits - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. These deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers and kame terraces.

Gleyed soil - An imperfectly or poorly drained soil in which the material has been modified by reduction or alternating reduction and oxidation. These soils have lower chromas or more prominent mottling or both in some horizons than the associated well-drained soil.

Gleysolic - An order of soils developed under wet conditions and permanent or periodic reduction. These soils have low chromas or prominent mottling or both, in some horizons.

Gravel - Rock fragments 2 mm to 7.5 cm in diameter.

Ground Moraine - An unsorted mixture of rocks, boulders, sand, silt and clay deposited by glacial ice. The predominant material is till; most till is thought to have accumulated under the ice by lodgment, but some till has been let down from the upper surface of the ice by ablation. Resorting and modification may have taken place to some extent by wave-action of glacial melt waters. The topography is most commonly in the form of undulating plains with gently sloping hills and enclosed depressions.

Groundwater - Water beneath the soil surface, usually under conditions where the voids are completely filled with water (saturation).

Halophytic vegetation - Vegetation that grows naturally in soils having a high content of various salts. It usually has fleshy leaves or thorns and resembles desert vegetation.

Horizon (soil) - A layer in the soil profile approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil forming processes.

Horizon boundary - The lower boundary of each horizon is described by indicating its distinctness and form. The distinctness depends on the abruptness of vertical change (thickness). The form refers to the variation of the boundary plane.

Distinctness -

abrupt -	less than 2 cm
clear -	2 to 5 cm
gradual -	5 to 15 cm
diffuse -	more than 15 cm

Form -

smooth - nearly plain
wavy - pockets are wider than deep
irregular - pockets are deeper than wide
broken - parts of the horizon are unconnected with other parts

Humic layer - A layer of highly decomposed organic soil material containing little fibre.

Hydraulic Conductivity - Refers to the effective flow velocity or discharge velocity in soil at unit hydraulic gradient. It is an approximation of the permeability of the soil and is expressed in cm per hour. The classes are described in general or specific terms as:

High	>15	Very rapid	>50
		Rapid	15-50
Medium	0.5-15	Mod. rapid	5.0-15
		Moderate	1.5-5.0
		Mod. slow	0.5-1.5
Low	<0.5	Slow	0.15-0.5
		Very slow	0.015-0.15
		Extremely slow	<.015

Hydrologic cycle - The conditions through which water naturally passes from the time of precipitation until it is returned to the atmosphere by evaporation and is again ready to be precipitated.

Hydrophyte - Plants growing in water or dependent upon wet or saturated soil conditions for growth.

Illuvial horizon - A soil horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension. The layer of accumulation.

Impeded drainage - A condition that hinders the movement of water by gravity through the soils.

Inclusion - Soil type found within a mapping unit that is not extensive
enough to be mapped separately or as part of a complex.

Infiltration - The downward entry of water into the soil

Irrigation - The artificial application of water to the soil for the benefit of growing crops.

Irrigation requirement (IR) - Refers to the amount of water exclusive of effective precipitation that is required for crop production.

Lacustrine deposits - Material deposited by or settled out of lake waters and exposed by lowering of the water levels or elevation of the land. These sediments range in texture from sand to clay and are usually varved (layered annual deposits).

Landforms - See Description of Landforms

Landscape - All the natural features such as fields, hills, forest, water, etc., which distinquish one part of the earth's surface from another part.

Leaching - The removal from the soil of materials in solution.

Liquid limit (upper plastic limit) -The water content corresponding to an arbitrary limit between the liquid and plastic states of consistency of a soil. The water content at this boundary is defined as that at which a pat of soil cut by a groove of standard dimensions will flow together for a distance of 1.25 cm under the impact of 25 blows in a standard liquid limit apparatus.

Lineal shrinkage - This is the decrease in one dimension expressed as a percentage of the original dimension of the soil mass when the moisture content is reduced from a stipulated percentage (usually field moisture equivalent) to the shrinkage limit.

Mapping Unit - Any delineated area shown on a soil map that is identified by a symbol. A mapping unit may be a soil unit, a miscellaneous land type, or a soil complex.

Marsh - Periodically flooded or continually wet areas having the surface not deeply submerged. It is covered dominantly with sedges, cattails, rushes or other hydrophytic plants.

Mature soil - A soil having well-developed soil horizons produced by the natural processes of soil formation.

Mesophyte - Plants requiring intermediate moisture conditions and are not very resistant to drought.

Microrelief - Small-scale, local differences in relief including mounds, swales or hollows.

Milliequivalent (me) - One-thousandth of an equival-

ent. An equivalent is the weight in grams of an ion or compound that combines with or replaces one gram of hydrogen. The atomic or formula weight divided by valence.

Mottles - Irregularly marked spots or streaks, usually yellow or orange but sometimes blue. They are described in order of abundance (few, common, many), size (fine, medium, coarse) and contrast (faint, distinct, prominent). Mottles in soils indicate poor aeration and lack of good drainage.

Organic carbon - Carbon derived from plant and animal residues.

Organic matter - The fraction of the soil which consists of plant and animal residues at various stages of decomposition, cells and tissues of soil organisms and substances synthesized by the soil population. It is determined on soils that have been sieved through a 2.0 mm sieve. It is estimated by multiplying the organic carbon by a factor of 1.72.

Outwash - Sediments "washed out" beyond the glacier by flowing water and laid down in thin beds or strata. Particle size may range from boulders to silt.

Ovendry soil - Soil that has been dried at 105 degrees C until it has reached constant weight.

Parent material - The unaltered or essentially unaltered mineral or organic material from which the soil profile develops by pedogenic processes.

Particle size, soil - The grain size distribution of the whole soil including the coarse fraction. It differs from texture, which refers to the fine earth (less than 2mm) fraction only. In addition, textural classes are usually assigned to specific horizons whereas soil family particle-size classes indicate a composite particle size of a part of the control section that may include several horizons. See Textural Triangle at end of Glossary.

The particle-size classes for family groupings are as follows:

Fragmental - Stones, cobbles and gravel, with too little fine earth to fill interstices larger than 1 mm.

Sandy-skeletal - Particles coarser than 2 mm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the sandy particle size class.

Loamy-skeletal - Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the loamy particle-size class.

Clayey-skeletal - Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the clayey particle size class.

Sandy - The texture of the fine earth includes sands and loamy sands, exclusive of loamy very fine sand and very fine sand textures; particles 2 mm- 25 cm occupy less than 35% by volume.

Loamy - The texture of the fine earth includes loamy very fine sand, very fine sand, and finer textures with less than 35% clay; particles 2 mm-25 cm occupy less than 35% by volume.

Coarse-loamy A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-loamy - A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Coarse-silty - A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-silty - A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Clayey - The fine earth contains 35% or more clay by weight and particles 2mm-25 cm occupy less than 35% by volume.

Fine-clayey - A clayey particle size that has 35-60% clay in the fine earth fraction.

Very-fine-clayey - A clayey particle size that has 60% or more clay in the fine earth fraction.

Ped - An individual soil aggregate such as granule, prism or block formed by natural processes (in contrast with a clod which is formed artificially).

Pedology - Those aspects of soil science involving constitution, distribution, genesis and classification of soils.

Percolation - The downward movement of water through soil; specifically, the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of 1.0 or less.

Permafrost -

1. Perennially frozen material underlying the solum.
2. A perennially frozen soil horizon.

Permafrost table - The upper boundary of permafrost, usually coincident with the lower limit of seasonal thaw (active layer).

Permeability - The ease with which water and air pass through the soil to all parts of the profile. See hydraulic conductivity.

pH - The intensity of acidity and alkalinity, expressed as the negative logarithm of the hydrogen ion concentration. A pH of 7 is neutral, lower values indicate acidity and higher values alkalinity (see Reaction, soil).

Phase, soil - A soil phase is used to characterize soil and landscape properties that are not used as criteria in soil taxonomy. The major phase differentiae are: slope, erosion, deposition, stoniness, texture, salinity, and calcareousness.

Plastic Limit - The water content corresponding to an arbitrary limit between the plastic and the semisolid states of consistency of a soil.

Plasticity Index - The numerical difference between the liquid and the plastic limit. The plasticity index gives the range of moisture contents within which a soil exhibits plastic properties.

Potential evapotranspiration (PE) - The maximum quantity of water capable of being lost as water vapor, in a given climate, by a continuous stretch of vegetation covering the whole ground and well supplied with water.

Profile, soil - A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil - The acidity or alkalinity of a soil.

Soil reaction classes are characterized as follows:

extremely acid	pH < 4.5
very strongly acid	4.5 to 5.0
strongly acid	5.1 to 5.5
medium acid	5.6 to 6.0
slightly acid	6.1 to 6.5
neutral	6.6 to 7.3
mildly alkaline	7.4 to 7.8
mod. alkaline	7.9 to 8.4
strongly alkaline	8.5 to 9.0
very strongly alkaline	>9.0

Regolith - The unconsolidated mantle of weathered rock and soil material on the earth's surface.

Relief - The elevation of inequalities of the land surface when considered collectively.

Runoff - The portion of the total precipitation on an area that flows away through stream channels. Surface runoff does not enter the soil. Groundwater runoff or seepage flow from groundwater enters the soil before reaching the stream.

Saline Soil - A nonalkali soil containing soluble salts in such quantities that they interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 millisiemens/cm (ms/cm), the exchangeable-sodium percentage is less than 15, and the pH is usually less than 8.5. Approximate limits of salinity classes are:

non-saline	0 to 4 mS/cm
weakly saline	4 to 8 mS/cm
mod. saline	8 to 15 mS/cm
strongly saline	>15 mS/cm

Salinization - The process of accumulation of salts in the soil.

Salt-Affected Soil - Soil that has been adversely modified for the growth of most crop plants by the presence of certain types of exchangeable

ions or of soluble salts. It includes soils having an excess of salts, or an excess of exchangeable sodium or both.

Sand - A soil particle between 0.05 and 2.0 mm in diameter. The textural class name for any soil containing 85 percent or more of sand and not more than 10 percent of clay.

Saturation Percentage - The moisture percentage of a saturated soil paste, expressed on an oven dry weight basis.

Seepage -

1. The escape of water downward through the soil.

2. The emergence of water from the soil along an extensive line of surface in contrast to a spring where water emerges from a local spot.

Series, soil - A category in the Canadian System of Soil Classification. It consists of soils that have soil horizons similar in their differentiating characteristics and arrangement in the profile, except for surface texture and are formed from a particular type of parent material.

Shrinkage limit - This is the moisture content at which an equilibrium condition of volume change is reached and further reduction in moisture content will not cause a decrease in the volume of the soil mass.

Shrinkage ratio - This is the ratio between the volume change and a corresponding change in moisture content. It equals the apparent specific gravity of the dried soil.

Silt - (a) Individual mineral particles of soil that range in diameter between 0.05 to .002 mm. (b) Soil of the textural class silt contains greater than 80 percent silt and less than 12 percent clay.

Slickenside - Smoothed surfaces along planes of weakness resulting from the movement of one mass of soil against another in soils dominated by swelling clays.

Sodium-Adsorption Ratio (S.A.R.) - A ratio for soil extracts and irrigation waters used to express the relative activity of sodium ions in exchange reactions with other cations in the soil SAR = $Na/((Ca+Mg)/2)^{1/2}$ where the cation concentrations are expressed as milliequivalents per litre.

Soil - The unconsolidated mineral material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Soil has been subjected to and influenced by genetic and environmental factors of: parent material, climate (including moisture and temperature effects), macro- and microorganisms, and topography, all acting over a period of time.

Solum - The upper horizons of a soil above the parent material and in which the processes of soil formation are active. It usually comprises the A and B horizons.

Stones - Rock fragments greater than 25 cm in diameter.

Stoniness - The percentage of land surface occupied by stones. The classes of stoniness are defined as follows:

Stones 0. Nonstony -- Land having less than 0.01% of surface occupied by stones.

Stones 1. Slightly stony -- Land having 0.01--0.1% of surface occupied by stones. Stones 15-30 cm in diameter, 10-30 m apart. The stones offer only slight to no hindrance to cultivation.

Stones 2. Moderately stony -- Land having 0.1-3% of surface occupied by stones. Stones 15-30 cm in diameter, 2-10 m apart. Stones cause some interference with cultivation.

Stones 3. Very stony -- Land having 3-15% of surface occupied by stones. Stones 15-30 cm in diameter, 1-2 m apart. There are sufficient stones to constitute a serious handicap to cultivation.

Stones 4. Exceedingly stony -- Land having 15-50% of surface occupied by stones. Stones 15-30 cm in diameter, 0.7-1.5 m apart. There are sufficient stones to prevent cultivation until considerable clearing has been done.

Stones 5. Excessively stony -- Land having more than 50% of surface occupied by stones. Stones 15-30 cm in diameter, less than 0.7 m apart. The land is too stony to permit cultivation.

Storage Capacity - Refers to the maximum amount of readily available water that can be stored within the rooting zone of a crop in a given soil. For practical irrigation purposes, 50 percent of the total soil water between field capacity and wilting point may be considered as readily available.

Stratified materials - Unconsolidated sand, silt and clay arranged in strata or layers. In stratified materials, a bed is a unit layer distinctly separable from other layers and is one or more cm thick but a lamina is a similar layer less than 1 cm thick.

Structure - The combination or arrangement of primary soil particles into aggregates of secondary soil particles, units or peds, which are separated from each other by surfaces of weakness. Structure is expressed in terms of grade, size class and shape type. Grade refers to the distinctness of aggregate development, and is described as structureless, weak, moderate or strong. Structureless refers to the absence of observable aggregation of definite orderly arrangement; the term amorphous is used if soil is massive or coherent, single-grained if non-coherent. The weak to strong aggregates vary in size and are described by class as fine, medium, coarse, and very coarse depending on the shape types. The shape types refers to the dominant configuration of the aggregates and the way they are accommodated. The general shape types are plate-like, block-like and prism-like. The terms are:

Platy - Having thin, plate-like aggregates with faces mostly horizontal.

Prismatic - Having prism-like aggregates with tops and edges, appear plane, level and somewhat angular.

Columnar - Having prism-like aggregates with vertical edges near the top of columns, not sharp.

Granular - Having block-like aggregates that appear as spheroids or polyhedrons having plane or curved surfaces which have slight or no accommodation to the faces of the surrounding peds.

Blocky - Having block-like aggregates with sharp, angular corners.

Subangular blocky - Having block-like aggregates with rounded and flattened faces and rounded corners.

By convention an aggregate is described in the order of grade, class and type, e.g. strong, medium, blocky. In the parent material of soils the material with structural shapes may be designated as pseudo-blocky, pseudo-platy, etc.

Soil Survey - The systematic examination, description, classification, and mapping of soil in an area.

Sulfate Hazard - Refers to the relative degree of attack on concrete by soil and water containing various amounts of sulfate ions. It is estimated from electrolyte measurements and salt analysis on selected profiles and soil sam-ples, and by visual examination of free gypsum within the profile during the course of soil investigation.

Swamp - See Description of Landforms

Texture, soil - The relative proportions of the fine earth (less than 2 mm.) fraction of a soil. Textural classes are usually assigned to specific horizons whereas family particle size classes indicate a composite particle size of a portion of the control section that may include several horizons. See Texture Triangle at end of Glossary. The size range of the constituent primary particles are as follows:

	Diameter (mm)
Very coarse sand	2.0-1.0
Coarse sand	1.0-0.5
Medium sand	0.5-0.25
Fine sand	0.25-0.10
Very fine sand	0.10-0.05
Silt	0.05-0.002
Clay	< 0.002
Fine clay	< 0.0002

Till, glacial - Unstratified glacial deposits consisting of clay, sand, gravel, and boulders intermingled in any proportion.

Tilth - The physical condition of soil as related to its ease of tillage, fitness as a seedbed, and its impedance to seedling emergency and root penetration.

Topography - Refers to the percent slope and the pattern or frequency of slopes in different

directions. A set of 10 slope classes are used to denote the dominant but not necessarily most abundant slopes within a mapping unit.

Slope Class	Slope Name	Percent slope	Approx. degrees
1	level	0-0.5	0
2	nearly level	.5-2.5	.3-1.5
3	very gentle	2-5	1-3
4	gentle	6-9	3.5-5
5	moderate	10-15	6-8.5
6	strong	16-30	9-17
7	very strong	31-45	17-24
8	extreme	46-70	25-35
9	steep	71-100	35-45
10	very steep	>100	>45

Underground runoff - (or seepage) Water flowing towards stream channels after infiltration into the ground.

Unified Soil Classification System| (engineering) - A classification system based on the identification of soils according to their particle size, gradation, plasticity index and liquid limit.

Urban Land - Areas so altered or obstructed by urban works or structures that identification of soils is not feasible.

Variant, soil - A soil whose properties are believed to be sufficiently different from other known soils to justify a new series name, but comprising such a limited geographic area that creation of a new series is not justified.

Varve - A distinct band representing the annual deposit in sedimentary materials regardless of origin and usually consisting of two layers, one thick light colored layer of silt and fine sand laid down in the spring and summer, and the other a thin, dark colored layer of clay laid down in the fall and winter.

Water balance, soil - Is the daily amount of readily available water retained by the soil. The daily soil-water balance is decreased by the amount that the daily consumptive use exceeds the daily rainfall. When daily rainfall exceeds the consumptive use, the daily balance increases by the amount of the difference unless the soil-water balance is at storage capacity, in which case the excess is assumed to be lost by runoff or deep percolation.

Water table - (groundwater surface; free water surface; groundwater elevation) Elevation at which the pressure in the water is zero with respect to the atmospheric pressure.

Water table depths - (cm)

Generally High	<100
Very High	0-50
Moderately High	250-100
Medium High	100-150
Generally Low	>150
Medium Low	150-200
Low	>200
Moderately Low	200-300
Very Low	>300

Water-holding capacity - The ability of a soil to hold water against the force of gravity in a freely drained soil.

Weathering - The physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.

Xerophyte - Plants capable of surviving extended periods of soil drought.

Figure 11. Family particle-size Classes

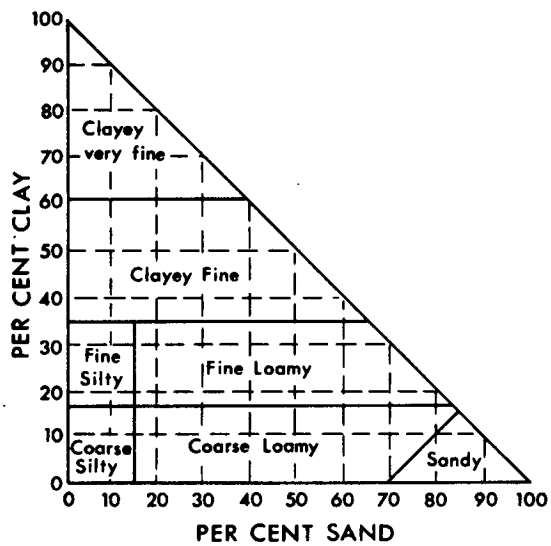
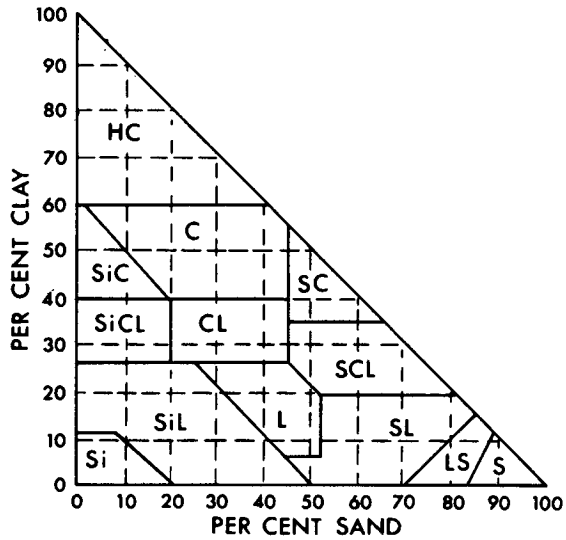


Figure 12. Soil Textural Classes



Texture Group	Class Symbol	Class Name
Coarse	S	sand
	LS	loamy sand
Moderately coarse	SL	sandy loam
	LVFS	loamy very fine sand
Medium	Si	silt
	SiL	silt loam
	L	loam
	VFSL	very fine sandy loam
Moderately fine	SCL	sandy clay loam
	CL	clay loam
	SiCL	silty clay loam
Fine	SC	sandy clay
	C	clay
	SiC	silty clay
Very fine	HC	heavy clay

APPENDIX D

SOIL HORIZON DESIGNATIONS

ORGANIC HORIZONS

Organic horizons are found in Organic soils, and commonly at the surface of mineral soils. They may occur at any depth beneath the surface in buried soils, or overlying geologic deposits. They contain more than 17% organic carbon (approximately 30% organic matter) by weight. Two groups of these horizons are recognized, O horizons and the L, F, and H horizons.

O This is an organic horizon developed mainly from mosses, rushes, and woody materials.

Of The fibric horizon is the least decomposed of all the organic soil materials. It has large amounts of well- preserved fiber that are readily identifiable as to botanical origin. A fibric horizon has 40% or more of rubbed fiber by volume and a pyrophosphate index of 5 or more. If the rubbed fiber volume is 75% or more, the pyrophosphate criterion does not apply.

Om The mesic horizon is the intermediate stage of decompostion with intermediate amounts of fiber, bulk density and water-holding capacity. The material is partly altered both physically and biochemically. A mesic horizon is one that fails to meet the requirements of fibric or humic.

Oh The humic horizon is the most highly decomposed of the organic soil materials. It has the least amount of fiber, the highest bulk density, and the lowest saturated water-holding capacity. It is very stable and changes very little physically or chemically with time unless it is drained. The humic horizon has less than 10% rubbed fiber by volume and a pyrophosphate index of 3 or less.

LFH These organic horizons developed primarily from leaves, twigs, woody materials and a minor component of mosses under imperfectly to well drained forest conditions.

L This is an organic horizon characterized by an accumulation of organic matter in which the original structures are easily discernible.

F This is an organic horizon characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The horizon may be partly comminuted by soil fauna as in moder, or it may be a partly decomposed mat permeated by fungal hyphae as in mor.

H This is an organic horizon characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification chiefly through the action of organisms. It is frequently intermixed with mineral grains, especially near the junction with the mineral horizon.

MASTER MINERAL HORIZONS

Mineral horizons are those that contain less than 30% organic matter by weight as specified for organic horizon.

A This is a mineral horizon or horizons formed at or near the surface in the zone of leaching or removal of materials in solution and suspension or of maximum in situ accumulation of organic matter, or both. Included are:

1. horizons in which organic matter has accumulated as a result of biological activity (Ah);
2. horizons that have been eluviated of clay, iron, alumin-ium, or organic matter, or all of them (Ae);
3. horizons having characteristics of 1) and 2) above but transitional to underlying B or C (AB or A and B);
4. horizons markedly disturbed by cultivation or pasture (Ap).

B This is a mineral horizon or horizons characterized by one or more of the following:

1. an enrichment in silicate clay, iron, aluminum, or humus, alone or in combination (Bt,Bf,Bfh,Bhf, and Bh);

2. a prismatic or columnar structure that exhibits pronounced coatings or stain-ings and significant amount of exchangeable Na (Bn);

3. an alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below, or both, and does not meet the requirements of 1) and 2) above (Bm,Bg).

C This is a mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting (i) the process of gleying, and (ii) the accumulation of calcium and magnesium carbonates and more soluble salts (Cca,Csa,Cg, and C). Marl and diatomaceous earth are considered to be C horizons.

R This is consolidated bedrock that is too hard to break with the hands or to dig with a spade when moist and that does not meet he requirement of a C horizon. The boundary between the R layer and overlying unconsolidated material is called a lithic contact.

W This is a layer of water in Gleysolic, Organic, or Cryosolic soils. It is called a hydric layer in Organic soils.

LOWER-CASE SUFFIXES

b Buried soil horizon.

c A cemented (irreversible) pedo-genic horizon. The ortstein of a Podzol, and a layer cemented by calcium carbonate and a duripan are examples.

ca A horizon with secondary carbonate enrichment where the concentration of lime exceeds that present in the unenriched parent material. It is more than 10 cm thick, and if it has a CaCO3 equivalent of less than 15 percent it should have at least 5 percent more CaCO3 equivalent than the parent material (IC). If it has more than 15 percent CaCO3 equivalent it should have 1/3 more CaCO3 equivalent than the IC. If no IC is present, this horizon is more than 10 cm thick and contains more than 5 percent by volume of secondary carbonates in concretions or soft, powdery forms.

cc Cemented (irreversible) pedogenic concretions.

e A horizon characterized by the eluviation of clay, iron, aluminum, or organic matter alone or in combination. When dry, it is usually higher in color value by 1 or more units than an underlying B horizon. It is used with A (Ae).

f A horizon enriched with amorphous material, principally Al and Fe combined with organic matter. It usually has a hue of 7.5YR or redder or its hue is 10YR near the upper boundary and becomes yellower with depth. When moist, the chroma is higher than 3 or the value is 3 or less. It contains 0.6% or more pyrophosphate-extractable Al+Fe in textures finer than sand and 0.4% or more in sands (coarse sand, sand, fine sand, and very fine sand). The ratio of pyrophosphate-extractable Al+Fe to clay (less than 0.002mm) is more than 0.05 and organic C exceeds 0.5%. Pyrophosphate-extractable Fe is at least 0.3%, or the ratio of organic C to pyrophosphate-extractable Fe is less than 20, or both are true. It is used with B alone (Bf), with B and h (Bhf), with B and g (Bfg), and with other suffixes. The criteria for "f" do not apply to Bgf horizons. The following horizons are differentiated on the basis of organic carbon content: Bf - 0.5% to 5% organic carbon. Bhf-more than 5% organic carbon.

g A horizon characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic intense reduction. Chromas of the matrix are generally 1 or less. It is used with A and e (Aeg); with B alone (Bg); with B and f (Bfg); with B, h, and f (Bhfg); with B and t (Btg); with C alone (Cg); with C and k (Ckg); and several others. In some reddish parent materials, matrix colors of reddish hues and high chromas may persist despite long periods of reduction. In these soils, horizons are designated as g if there is gray mottling or if there is marked bleaching on ped faces or along cracks.

Aeg This horizon must meet the definitions of A,e, and g.

Bg These horizons are analogous to Bm horizons but they have colors indicative of poor drainage and periodic reduction. They include horizons occurring between A and C horizons in which the main features are (i) colors of low chroma, that is: chromas of 1 or less, without mottles on ped surfaces or in the matrix if peds are

lacking; or chromas of 2 or less in hues of 10YR or redder, on ped surfaces or in the matrix if peds are lacking, accompanied by more prominent mottles than those in the C horizon; or hues bluer than 10Y, with or without mottles on ped surfaces or in the matrix if peds are lacking. (ii) colors indicated in (i) and a change in structure from that of the C horizons. (iii) color indicated in (i) and illuviation of clay too slight to meet the requirements of Bt; or accumulation or iron oxide too slight to meet the limits of Bgf. (iv) colors indicated in (i) and removal of carbonates. Bg horizons occur in some Orthic Humic Gleysols and some Orthic Gleysols.

Bfg, Bhfg, Btg, and others. When used in any of these combinations the limits set for f, hf, t, and others must be met.

Bgf The dithionite-extractable Fe of this horizon exceeds that of the IC by 1% or more. Pyrophosphate-extractable Al + Fe is less than the minimum limit specified for 'f' horizons. This horizon occurs in Fera Gleysols and Fera Humic Gleysols, and possibly below the Bfg of gleyed Podzols. It is distinguished from the Bfg of gleyed Podzols on the basis of the extractability of the Fe and Al. The Fe in the Bgf horizon is thought to have accumulated as a result of the oxidation of ferrous iron. The iron oxide formed is not associated intimately with organic matter or with Al, and it is sometimes crystalline. The Bgf horizons are usually prominently mottled, with more than half of the soil material occurring as mottles of high chroma.

Cg, Ckg, Ccag, Csg, Csag. When g is used with C alone, or with C and one of the lowercase suffixes k, ca, s, or sa, it must meet the definition for C and for the particular suffix.

h A horizon enriched with organic matter. It is used with A alone (Ah); or with A and e (Ahe); or with B alone (Bh); or with B and f (Bhf).

Ah A horizon enriched with organic matter that either has a color value at least one unit lower than the underlying horizon or contains 0.5% more organic carbon than the IC, or both. It contains less than 17% organic carbon by weight.

Ahe An Ah horizon that has undergone eluviation as evidenced, under natural conditions, by streaks and splotches of differing shades of gray and often by platy structure. It may be overlain by a darker-colored Ah and underlain by a lighter colored Ae.

Bh This horizon contains more than 1% organic carbon, less than 0.3% pyrophosphate-extractable Fe, and has a ratio of organic carbon to pyrophosphate-extractable of 20 or more. Generally the color value and chroma are less than 3 when moist.

Bhf Defined under 'f'.

j Used as a modifier of the suffixes e, f, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies. It must be placed to the right and adjacent to the suffix it modifies. For example Bfgj means a Bf horizon with weak expression of gleying; Bfjgj means a B horizon with weak expression of both 'f' and 'g' features.

Aej It denotes an eluvial horizon that is thin, discontinuous or slightly discernible.

Btj It is a horizon with some illuviation of clay, but not enough to meet the limits of Bt.

Btgj, Bmgj. Horizons that are mottled but do not meet the criteria of Bg.

Bfj It is a horizon with some accumulation of pyrophosphate-extractable Al and Fe but not enough to meet the limits of Bf.

Bntj or Bnj. Horizons in which development of solonetzic B properties is evident but insufficient to meet the limits for Bn or Bnt.

k Denotes the presence of carbonate, as indicated by visible effervescence when dilute HCl is added. Most often it is used with B and m (Bmk) or C (Ck), and occasionally with Ah or Ap (Ahk, Apk), or organic horizons (Ofk, Omk).

m A horizon slightly altered by hydrolysis, oxidation, or solution, or all three, to give a change in color or structure, or both. It has:

1. Evidence of alteration in one of the following forms:

   a) Higher chromas and redder hues than the underlying horizons.

   b) Removal of carbonates, either partially (Bmk) or completely (Bm).

2. Illuviation, if evident, too slight to meet the requirements of a Bt or a podzolic B.

3. Some weatherable minerals.

4. No cementation or induration and lacks a brittle consistence when moist. This suffix can be used as Bm, Bmgj, Bmk, and Bms.

n A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. It must also have the following distinctive morphological characteristics: prismatic or columnar structure, dark coatings on ped surfaces, and hard to very hard consistence when dry. It is used with B, as Bn or Bnt.

p A horizon disturbed by man's activities, such as cultivation, logging, habitation, etc. It is used with A and O.

s A horizon with salts, including gypsum, which may be detected as crystals or veins, as surface crusts of salt crystals, by depressed crop growth, or by the presence of salt-tolerant plants. It is commonly used with C and k (Csk), but can be used with any horizon or combination of horizon and lowercase suffix.

sa A horizon with secondary enrichment of salts more soluble than calcium and magnesium carbonates, in which the concentration of salts exceeds that present in the unenriched parent material. The horizon is 10 cm or more thick. The conductivity of the saturation extract must be at least 4 ms/cm and must exceed that of the C horizon by at least onethird.

t An illuvial horizon enriched with silicate clay. It is used with B alone (Bt), with B and g (Btg), with B and n (Bnt), etc.

Bt A Bt horizon is one that contains illuvial layer lattice clays. It forms below an eluvial horizon, but may occur at the surface of a soil that has been partially truncated. It usually has a higher ratio of fine clay to total clay than IC. It has the following properties:

1. If any part of an eluvial horizon remains and there is no lithologic discontinuity between it and the Bt horizon, the Bt horizon contains more total and fine clay than the eluvial horizons, as follows:

   a) If any part of the eluvial horizon has less than 15% total clay in the fine earth fraction (2mm) the Bt horizon must contain at least 3% more clay, e.g., Ae 10% clay Bt minimum 13% clay.

   b) If the eluvial horizon has more than 15% and less than 40% total clay in the fine earth fraction, the ratio of the clay in the Bt horizon to that in the eluvial horizon must be 1.2 or more, e.g., 20% clay increase in the Bt over Ae.

   c) If the eluvial horizon has more than 40% total clay in the fine earth fraction, the Bt horizon must contain at least 8% more clay than the eluvial horizon, e.g. Ae 50% clay; Bt at least 58% clay.

2. A Bt horizon must be at least 5 cm thick. In some sandy soils where clay accumulation occurs in the lamellae, the total thickness of the lamellae should be more than 10 cm in the upper 150 cm of the profile.

3. In massive soils the Bt horizon should have oriented clays in some pores and also as bridges between the sand grains.

4. If peds are present, a Bt horizon shows clay skins on some of the vertical and horizontal ped surfaces and in the fine pores, or shows oriented clays in 1% or more of the cross section, as viewed in thin section.

5. If a soil shows a lithologic discontinuity between the eluvial horizon and the Bt horizon, or if only a plow layer overlies the Bt horizon, the Bt horizon need show only clay skins in some part, either in some fine pores or on some vertical and horizontal ped surfaces. Thin sections should show that some part of the horizon has about 1% or more of oriented clay bodies.

Btj, Btj, and Btg are defined under j and g.

u A horizon that is markedly disrupted by physical or faunal processes other than cryoturbation. Evidence of marked disruption such as the inclusion of material from other horizons, absence of the horizon, etc. must be evident in at least half of the cross section of the pedon. Such turbation can result from blowdown of trees, mass movement of soil on slopes, and burrowing animals. It can be used with any horizon or subhorizon with the exception of A or B alone; e.g. Aeu, Bfu, BCu.

x A horizon of fragipan character. A fragipan is a loamy subsurface horizon of high bulk density and very low organic matter content. When dry, it has a hard consistence and seems to be cemented. When moist, it has moderate to weak brittleness. It frequently has bleached fracture planes and is overlain by a friable B horizon. Air dry clods of fragic horizons slake in water.

y A horizon affected by cryoturbation as manifested by disrupted and broken horizons, incorporation of materials from other horizons and mechanical sorting in at least half of the cross section of the pedon. It is used with A, B, and C alone or in combination with other subscripts, e.g. Ahy, Ahgy, Bmy, Cy, Cgy, Cygj, etc.

z A frozen layer. It may be used with any horizon or layer, e.g. Ohz, Bmz, Cz, Wz.

APPENDIX E

DESCRIPTION OF LANDFORMS

GENETIC MATERIALS

Unconsolidated mineral component

The unconsolidated mineral component consists of clastic sediments that may or may not be stratified, but whose particles are not cemented together. They are essentially of glacial or post-glacial origin but include poorly consolidated and weathered bedrock.

Anthropogenic - Man-made or man-modified materials, including those associated with mineral exploitation and waste disposal.

Colluvial - Massive to moderately well stratified, nonsorted to poorly sorted sediments with any range of particle sizes from clay to boulders and blocks that have reached their present position by direct, gravity-induced movement.

They are restricted to products of mass-wasting whereby the debris is not carried by wind, water, or ice (excepting snow avalanches).

Eolian - Sediment, generally consisting of medium to fine sand and coarse silt particle sizes, that is well sorted, poorly compacted,and may show internal structures such as cross bedding or ripple laminae, or may be massive. Individual grains may be rounded and show signs of frosting.

These materials have been transported and deposited by wind action.

Fluvial - Sediment generally consisting of gravel and sand with a minor fraction of silt and clay. The gravels are typically rounded and contain interstitial sand. Fluvial sediments are commonly moderately to well sorted and display stratification, but massive, nonsorted fluvial gravels do occur. These materials have been transported and deposited by streams and rivers. Finer textured Fluvial deposits of modern rivers are termed Alluvium.

Lacustrine - Sediment generally consisting of either stratified fine sand, silt, and clay deposited on the lake bed; or moderately well sorted and stratified sand and coarser materials that are beach and other nearshore sediments transported and deposited by wave action.

These are materials that either have settled from suspension in bodies of standing fresh water or have accumulated at their margins through wave action.

Marine - Unconsolidated deposits of clay, silt, sand, or gravel that are well to moderately well sorted and well stratified to moderately stratified (in some places containing shells). They have settled from suspension in salt or brackish water bodies or have accumulated at their margins through shoreline processes such as wave action and longshore drift.

Morainal - Sediment generally consisting of well compacted material that is nonstratified and contains a heterogeneous mixture of particle sizes, often in a mixture of sand, silt, and clay that has been transported beneath, beside, on, within and in front of a glacier and not modified by any intermediate agent.

Saprolite - Rock containing a high proportion of residual silts and clays formed by alteration, chiefly by chemical weathering.

The rock remains in a coherent state, interstitial grain relationships are undisturbed and no downhill movement due to gravity has occurred.

Undifferentiated - A layered sequence of more than three types of genetic material outcropping on a steep erosional escarpment.

Volcanic - Unconsolidated pyroclastic sediments. These include volcanic dust, ash, cinders, and pumice.

Qualifying Descriptors

These have been introduced to qualify the genetic materials and to supply additional information about the mode of formation or depositional environment.

Glacial - Used to qualify nonglacial genetic materials or process modifiers where there is direct evidence that glacier ice exerted a strong but sec-

ondary or indirect control upon the mode of origin of the materials or mode of operation of the process. The use of this qualifying descriptor implies that glacier ice was close to the site of the deposition of a material or the site of operation of a process.

Glaciofluvial - Fluvial materials showing clear evidence of having been deposited either directly in front of or in contact with glacier ice.

Glaciolacustrine - Lacustrine materials deposited in contact with glacial ice.

Glaciomarine - Materials of glacial origin laid down in a marine environment, as a result of settling from melting, floating ice and ice shelves.

Organic component

The organic component consists of peat deposits containing > 30% organic matter by weight that may be as thin as 10 cm if they overlie bedrock but are otherwise greater than 40 cm and generally greater than 60 cm thick.
The classes and their definitions follow.

B	Bog
N	Fen
S	Swamp

Bog - A bog is a peat-covered or peat-filled area, generally with a high water table. Since the surface of the peatland is slightly elevated, bogs are either unaffected or partly aFfected by nutrientrich groundwaters from the surrounding mineral soils. The groundwater is generally acidic and low in nutrients (ombrotrophic). The dominant peat materials are sphagnum and forest peat, underlain, at times, by fen peat.

Fen - A fen is a peat-covered or peat-filled area with a high water table, which is usually at the surface. The dominant materials are shallow to deep, well to moderately decomposed fen peat. The waters are mainly rich in nutrients (minerotrophic) and are derived from mineral soils. The peat materials are therefore higher in both nutrients and pH than the peats associated with bogs.

Swamp - A swamp is a peat-covered or peat-filled area. The peat surface is level or slightly concave in cross section. The water table is frequently at or above the peat surface. There is strong water movement from margins or other mineral sources. The microrelief is hummocky, with many pools present. The waters are neutral or slightly acid. The dominant peat materials are shallow to deep mesic to humic forest and fen peat.

GENETIC MATERIAL MODIFIERS

Material modifiers are used to qualify unconsolidated mineral and organic deposits. Particle-size classes serve to indicate the size, roundness, and sorting of unconsolidated mineral deposits. Fiber classes indicate the degree of decomposition and fiber size of organic materials.

Particle size classes for unconsolidated mineral materials

Blocky: An accumulation of angular particles greater than 256 mm in size.

Bouldery: An accumulation of rounded particles greater than 256 mm in size.

Clayey: An accumulation of particles where the fine earth fraction contains 35% or more clay (< 0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Cobbly: An accumulation of rounded particles having a diameter of 64-256 mm.

Gravelly: An accumulation of rounded particles ranging in size from pebbles to boulders.

Loamy: An accumulation of particles of which fine earth fraction contains 35% or less clay (< 0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Pebbly: An accumulation of rounded particles having a diameter of 2-64 mm.

Rubbly: An accumulation of angular fragments having a diameter of 2-256 mm.

Sandy: An accumulation of particles of which the fine earth fraction contains more than 70% by weight of fine sand or coarser particles. Particles greater than 2 mm occupy less than 35% by volume.

Silty: An accumulation of particles of which the fine earth fraction contains less than 15%

of fine sand or coarser particles and has less than 35% clay. Particles greater than 2 mm occupy less than 35% by volume.

Fiber classes for organic materials

The amount of fiber and its durability are important characterizing features of organic deposits in that they reflect on the degree of decomposition of the material. The prevalence of woody materials in peats is also of prime importance.

Fibric: The least decomposed of all organic materials; there is a large amount of well preserved fiber that is readily identifiable as to botanical origin. Fibers retain their character upon rubbing.

Mesic: Organic material in an intermediate stage of decompostion; intermediate amounts of fiber are present that can be identified as to their botanical origin.

Humic: Highly decomposed organic material; small amounts of fiber are present that can be identified as to their botanical origin. Fibers can be easily destroyed by rubbing.

Woody: Organic material containing more than 50% of woody fibers.

SURFACE EXPRESSION

The surface expression of genetic materials is their form (assemblage of slopes) and pattern of forms. Form as applied to unconsolidated deposits refers specifically to the product of the initial mode of origin of the materials. When applied to consolidated materials, form refers to the product of their modification by geological processes. Surface expression also indicates the manner in which unconsolidated genetic materials relate to the underlying unit.

Consolidated and Unconsolidated mineral surface classes

Apron - A relatively gentle slope at the foot of a steeper slope and formed by materials from the steeper, upper slope.

Blanket - A mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but still conforming to the general underlying topography.

Fan - A fan-shaped form similar to the segment of a cone and having a perceptible gradient from the apex to the toe.

Hummocky - A very complex sequence of slopes extending from somewhat rounded depressions or kettles of various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls or depressions. Slopes are generally 9-70% (5-35 degrees).

Inclined - A sloping, unidirectional surface with a generally constant slope not broken by marked irregularities. Slopes are 2-70% (1-35 degrees). The form of inclined slopes is not related to the initial mode of origin of the underlying material.

Level - A flat or very gently sloping, unidirectional surface with a generally constant slope not broken by marked elevations and depressions. Slopes are generally less than 2% (1 degree).

Rolling - A very regular sequence of moderate slopes extending from rounded, sometimes confined concave depressions to broad, rounded convexities producing a wavelake pattern of moderate relief. Slope length is often 1.6 km or greater and gradients are greater than 5% (3 degrees).

Ridged - A long, narrow elevation of the surface, usually sharp crested with steep sides. The ridges may be parallel, subparallel, or intersecting.

Steep - Erosional slopes, greater than 70% (35 degrees), on both consolidated and unconsolidated materials. The form of a steep erosional slope on unconsolidated materials is not related to the initial mode of origin of the underlying material.

Terraced - Scarp face and the horizontal or gently inclined surface (tread) above it.

Undulating - A very regular sequence of gentle slopes that extends from rounded, sometimes confined concavities to broad rounded convexities producing a wavelike pattern of low local relief. Slope length is generally less than 0.8 km and the dominant gradient of slopes is 2-5% (1-3 degrees).

Veneer - Unconsolidated materials too thin to mask the minor irregularities of the underlying unit

surface. A veneer will range from 10 cm to 1 m in thickness and will possess no form typical of the material's genesis.

Organic surface classes

Blanket - A mantle of organic materials that is thick enough to maskminor irregularities in the underlying unit but still conforms to the general underlying topography.

Bowl - A bog or fen occupying concave-shaped depressions.

Domed - A bog with an elevated, convex, central area much higher than the margin. Domes may be abrupt (with or without a frozen core) or gently sloping or have a stepped surface.

Floating - A level organic surface associated with a pond or lake and not anchored to the lake bottom.

Horizontal - A flat peat surface not broken by marked elevations and depressions.

Plateau - A bog with an elevated, flat, central area only slightly higher than the margin.

Ribbed - A pattern of parallel or reticulate low ridges associated with fens.

Sloping - A peat surface with a generally constant slope not broken by marked irregularities.

Veneer - A thin (40 cm-1m) mantle of organic materials which generally conforms to the underlying topography. They may or may not be associated with discontinuous permafrost.

APPENDIX F

Daily Site Descriptions and Detailed Soil Descriptions Data

During the course of the field program, approximately 3400 **Daily Site Description Forms** were filled out to capture site and landscape observations covering the municipality. These daily site observations are backed up with grab samples for laboratory analysis to confirm suspicions that can not be sufficiently determined on site, e.g. textural class or presence of salts.

There are nineteen profiles that were characterized with observations recorded in a **Detailed Soil Description Form**. All nineteen profiles were sampled and brought to the laboratory for physical and chemical analysis.

The data accumulated from Daily Site Descriptions, Detailed Soil Description and laboratory analysis performed on the soil samples have resulted in the generation of voluminous information that can no longer be accommodated in this report. This data now resides in one of the several Canada-Manitoba Soil Survey Databases.

For Daily Site Descriptions, it can be accessed on an interactive basis through the University of Manitoba Computer System by way of the Soil Information Management System(%Soils). For the R.M. of Rhineland a project code RLD was assigned and used for selection and querying of the database. Similarly, the Detailed Soil Descriptions data (profiles) can also be accessed the same way in a batch mode. A printed output is generated and can be picked up at the I/O window of the Computer Centre on the 6th Floor, Engineering Bldg, University of Manitoba.

In both cases, a TSO user ID and account number with the University of Manitoba Computer System is necessary to be able to logon to the computer system. For assistance and specialized request of soil data contact: Canada-Manitoba Soil Survey, Department of Soil Science, Rm 362 Ellis Bldg., University of Manitoba, Winnipeg, Manitoba R3T 2N2.

Selected Detailed Profile Descriptions Available for the R.M. of Rhineland

Series Name	Location	Sample Year	Site No.
Eigenhof (EGF)	NE 15-1-2W	1986	5
Gretna (GRA)	SW 1-1-2W	1986	6
Plum Coulee (PME)	SE 27-1-1W	1986	7
Plum Coulee (PME)	NE 21-1-1W	1986	8
Neuenberg (NBG)	SW 32-1-2W	1986	9
Rignold (RGD)	SE 5-1-2W	1986	10
Lakeland (LKD)	SW 24-1-1E	1987	9
Hoddinott (HDN)	NE 13-1-1E	1987	10
Neuhorst (NUH)	NW 31-1-1E	1987	11
Plum Coulee (PME)	NE 20-1-1E	1987	12
Gnadenthal (GDH)	NE 7-2-2W	1987	13
Neuhorst (NUH)	NW 25-2-2W	1987	14
Graysville (GYV)	NW 27-2-2W	1987	15
Osborne (OBO)	SE 25-3-1W	1988	1
Glenmoor (GOO)	SE 25-3-1W	1988	2
Newton Siding (NWN)	NW 19-2-1W	1988	3
Horndean (HND)	NW 23-2-1W	1988	4
Lakeland (LKD)	C 34-1-1E	1988	5
Morris (MRS)	SE 18-3-1W	1988	6

Figure 13. Drill and Sample Sites

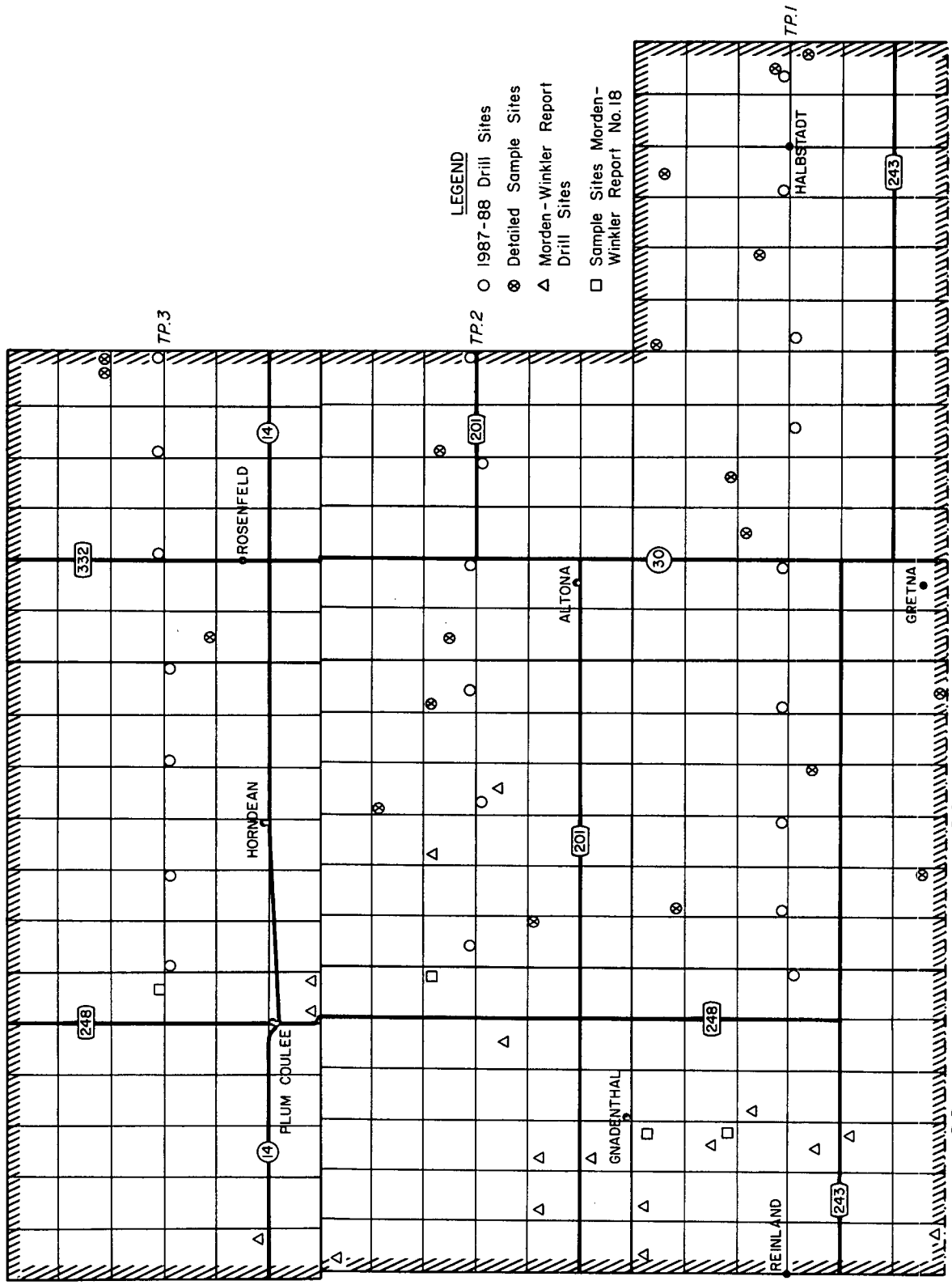


Table 29. DRILL DATA AND ANALYSIS
(3 Pages)

Depth	Text. Class	pH	Cond	Org. C	CaCO3	Calc.	Dolo.	Ca	Mg	Na	K	C.E.C. Calc.	C.E.C.	Sat.
** SITE: 1	LOCATION: SE24-02-01W Series PME													
0-90	C	7.7	4.2	1.45	11.1	0.0	0.0	19.1	25.1	2.8	0.9	47.9	41.9	111.2
90-180	SICL	7.8	3.6	0.40	35.0	2.8	29.4	12.9	12.3	1.5	0.5	27.2	19.9	59.0
180-240	C	7.6	4.1	0.00	5.2	1.4	3.5	36.4	20.8	2.2	0.8	60.2	36.0	107.0
240-310	C	7.6	3.7	0.00	6.6	2.3	4.0	51.7	18.9	1.9	0.8	73.3	33.9	106.6
** SITE: 2	LOCATION: NE15-02-01W Series PME													
0-40	C	7.8	5.1	1.30	6.2	4.9	1.2	31.2	26.1	4.0	0.6	61.9	39.9	99.0
40-110	CL	8.0	5.6	0.38	20.7	3.2	16.1	12.5	16.5	3.2	0.5	32.7	19.7	60.0
110-190	SICL	7.8	6.7	0.00	19.5	0.6	17.4	18.0	15.1	2.5	1.3	36.4	20.2	64.6
190-240	C	7.7	5.3	0.00	7.8	3.7	3.8	8.2	23.9	3.7	0.7	86.5	36.0	114.0
** SITE: 3	LOCATION: SE20-02-01W Series PME													
0-90	C	7.7	4.2	2.26	21.3	10.3	10.2	45.9	10.8	1.2	0.8	58.7	28.0	64.4
90-160	SIL	7.8	6.3	0.46	18.9	4.0	13.6	22.2	13.8	2.2	0.8	39.0	16.9	61.4
160-310	L	7.8	10.6	0.00	17.0	0.6	15.1	5.0	13.5	2.9	0.4	21.8	8.5	45.0
310-410	SICL	7.9	7.7	0.00	17.5	1.4	14.8	24.2	18.0	3.6	0.7	46.5	17.5	74.0
** SITE: 4	LOCATION: SW24-02-02W Series GDH													
0-40	SCL	7.7	0.7	1.68	9.2	6.8	2.3	13.6	8.1	0.1	0.1	21.9	15.6	49.4
40-160	VFSL	7.8	1.0	2.49	19.3	5.7	12.6	6.9	6.2	0.0	0.0	13.1	6.5	37.7
160-310	LVFS	7.8	0.7	0.00	13.5	0.9	11.6	6.2	4.6	0.3	0.6	11.7	6.4	38.6
310-410	C	7.7	1.1	0.00	7.2	2.5	4.4	14.5	14.2	0.5	0.7	29.9	28.9	114.0
** SITE: 5	LOCATION: NW15-02-02W Series PME													
0-40	C	7.5	0.8	2.55	1.4	0.5	0.8	15.6	9.7	0.1	1.0	25.4	34.8	68.9
40-160	SIL	7.8	0.9	0.48	28.2	8.3	18.4	9.7	8.3	0.3	0.4	18.7	16.6	54.0
160-310	C	7.5	2.9	0.00	7.8	4.8	2.8	31.5	13.8	0.7	1.0	47.0	33.6	112.0
** SITE: 6	LOCATION: SW19-02-02W Series GDH													
0-40	SCL	7.9	1.4	1.44	6.7	5.6	1.0	8.5	12.3	1.2	0.2	22.2	17.3	52.0
40-90	VFSL	7.9	1.3	0.36	15.2	6.6	7.9	7.7	7.5	0.8	0.3	16.3	9.3	42.7
90-200	SICL	7.8	4.3	0.39	18.3	4.1	13.0	12.2	15.4	1.8	0.6	30.0	21.3	77.0
200-240	C	7.8	6.7	0.00	8.1	4.1	3.7	32.9	28.5	4.1	0.8	66.3	37.1	130.0
** SITE: 7	LOCATION: SW24-01-01W Series LKD													
0-40	SICL	7.8	6.2	2.80	25.5	14.3	10.3	17.0	17.6	3.4	0.3	38.3	30.7	14.2
40-130	SICL	8.0	10.5	0.47	26.7	1.4	23.3	22.8	24.4	7.0	1.1	55.3	18.4	68.0
130-210	C	7.7	8.8	0.00	8.7	1.5	6.6	30.1	31.5	7.8	1.9	71.3	34.7	118.0
210-280	C	7.8	9.7	0.00	12.3	0.8	10.6	11.4	31.0	9.1	0.7	52.2	34.8	104.0
280-310	C	7.8	9.5	0.00	4.8	3.0	1.6	19.4	35.7	10.3	0.7	66.1	40.7	129.0
** SITE: 8	LOCATION: SW22-01-01E Series DCS													
0-40	SIC	7.7	3.7	1.68	16.9	6.3	9.8	20.3	16.0	1.6	0.5	38.4	35.4	79.3
40-170	SIL	7.8	7.3	0.38	23.2	2.3	19.2	11.9	15.8	3.9	0.1	31.7	20.4	65.5
170-280	SIL	7.7	7.4	0.00	19.9	2.0	16.5	12.2	14.7	4.3	0.3	31.5	17.9	72.0
280-310	SIC	7.7	6.9	0.00	17.2	2.5	13.6	28.5	17.2	5.4	0.4	51.5	24.4	90.0

Table 29. DRILL DATA AND ANALYSIS(Cont'd)

Depth	Text. Class	pH	Cond	Org. C	CaCO3	Calc.	Dolo.	Ca	Mg	Na	K	C.E.C. Calc.	C.E.C.	Sat.
** SITE: 9	LOCATION: NW18-01-01E Series PME													
0-70	C	7.7	2.6	1.87	11.4	6.3	4.7	20.6	17.4	1.1	0.7	39.8	38.5	84.1
70-200	SICL	7.7	6.9	0.34	21.3	2.6	17.2	33.0	13.4	3.5	0.2	50.1	17.2	66.0
200-360	SIL	7.7	10.0	0.00	22.2	1.2	19.4	11.9	14.2	4.2	0.3	30.6	12.8	57.0
360-410	SICL	7.7	8.6	0.00	17.4	10.5	14.6	20.6	18.0	5.4	0.5	44.5	17.9	77.4
** SITE: 10	LOCATION: NE14-01-01W Series EGF													
0-50	C-CL	7.6	2.0	1.78	6.9	5.0	1.9	22.1	8.4	0.5	0.5	31.5	32.0	76.3
50-90	L	7.8	3.0	0.58	14.7	9.1	5.2	13.2	11.9	0.7	0.3	26.1	21.8	68.5
90-160	C	7.6	3.9	0.84	6.1	4.2	1.7	30.7	18.3	2.3	0.8	52.1	38.0	109.7
160-240	SICL	7.8	4.6	0.00	18.0	0.0	16.6	42.9	11.9	2.1	0.4	57.3	22.6	73.0
240-310	SIL	7.8	4.5	0.00	21.5	0.0	19.8	10.8	10.0	2.0	0.3	23.1	17.8	66.1
** SITE: 11	LOCATION: SE20-01-01W Series PME													
0-90	C	7.6	10.8	3.01	0.7	0.2	0.5	24.3	24.0	17.6	0.8	66.7	44.4	114.9
90-240	SIC	7.8	7.9	0.00	10.3	8.2	1.9	30.9	17.0	11.7	0.6	60.2	34.6	113.0
** SITE: 12	LOCATION: SW24-01-02W Series EGF													
0-200	CL	7.7	3.6	1.20	10.7	4.1	6.1	17.5	12.7	0.8	0.5	31.5	23.2	66.5
200-240	SIL	7.7	4.6	0.00	21.9	0.6	19.6	31.5	12.1	1.0	0.3	44.9	16.5	62.3
240-410	SIL	7.7	4.3	0.00	21.3	0.4	19.2	21.3	11.1	0.8	0.2	33.4	15.0	58.0

Table 29. DRILL DATA AND ANALYSIS(Cont'd)

Depth	Text. Class	pH	Cond	Org. C	CaCO3	Calc.	Dolo.	Sat.	Ca	Mg	Na	SALTS SO4	Cl	HCO3
** SITE: 13	LOCATION: SE21-01-02W Series PME													
0-120	C	8.3	4.8	1.03	13.0	13.0	0.0	111.6	8.7	22.2	37.4	58.1	4.4	2.8
120-210	L	8.1	9.2	0.00	21.2	1.8	17.9	47.4	17.9	71.4	66.9	135.2	16.5	2.3
210-300	C	8.1	7.5	0.00	7.0	7.0	0.0	142.1	16.3	53.3	47.5	108.2	7.2	2.0
** SITE: 14	LOCATION: SW20-01-02W Series RGD													
0-50	CL	7.2	0.5	1.99	0.0	0.0	0.0	53.6	0.0	0.0	0.0	0.0	0.0	0.0
50-200	C	8.0	6.9	0.00	5.6	3.8	1.6	149.1	16.7	76.3	30.0	113.2	3.1	2.0
200-300	C	7.8	8.5	0.00	6.4	4.3	1.9	128.4	17.4	88.1	37.3	140.0	5.9	2.1
** SITE: 15	LOCATION: NE13-01-03W Series NBG													
0-80	VFSL	7.8	2.1	0.64	1.3	0.0	0.0	42.0	10.1	14.4	6.2	26.4	2.4	2.1
80-160	VFSL	7.6	1.8	0.00	3.8	0.0	3.5	44.0	10.3	10.0	6.1	24.1	1.8	1.7
160-240	L	7.5	1.0	0.00	13.7	4.4	8.5	48.5	0.0	0.0	0.0	0.0	0.0	0.0
240-300	VFSL	7.6	0.6	0.00	12.9	2.8	9.3		0.0	0.0	0.0	0.0	0.0	0.0
** SITE: 16	LOCATION: SE24-03-01W Series OBO													
0-90	C	7.9	3.3	1.15	7.7	7.7	0.0	108.9	5.4	10.0	27.2	45.3	0.0	2.5
90-200	C	7.7	6.5	0.00	8.6	8.6	0.0	109.1	16.2	50.6	38.6	100.4	3.0	1.9
200-300	C	7.7	5.2	0.00	6.1	0.0	5.6	124.3	17.3	32.5	28.8	75.0	3.7	1.9
** SITE: 17	LOCATION: SW23-03-01W Series GOO													
0-90	SIL	8.0	1.6	0.91	11.7	11.7	0.0	107.9	1.8	3.6	14.4	17.2	1.1	2.4
90-150	C	8.1	6.2	0.00	7.5	7.5	0.0	116.0	17.6	46.3	38.6	99.0	2.6	1.9
150-300	C	7.6	5.6	0.00	7.0	2.9	3.7	117.7	17.7	33.5	34.9	83.1	3.5	1.6
** SITE: 18	LOCATION: SW21-03-01W Series OBO													
0-140	C	8.1	7.5	1.10	9.0	9.0	0.0	97.8	17.3	64.6	49.0	122.3	2.5	2.3
140-200	C	7.8	7.4	0.00	7.4	0.9	6.3	104.5	16.7	55.3	47.2	114.5	3.4	2.3
200-300	SIC	7.9	6.1	0.00	7.1	2.9	3.7	119.6	17.8	42.5	39.9	98.4	4.8	2.2
** SITE: 19	LOCATION: NE13-03-02W Series OBO													
0-90	C	8.0	5.6	1.27	6.1	4.6	1.3	99.3	13.7	42.8	29.7	85.0	3.5	2.2
90-200	SIC	7.6	5.7	0.00	7.4	3.8	3.3	103.8	19.8	47.2	30.8	95.6	4.4	2.6
200-300	C	7.8	4.6	0.00	6.7	3.1	3.3	134.7	17.5	29.7	21.1	65.6	3.5	1.8
** SITE: 20	LOCATION: NW14-03-02W Series RGD													
0-40	SCL	7.7	0.9	1.65	2.9	0.9	1.9	51.8	0.0	0.0	0.0	0.0	0.0	0.0
40-90	VFSL	8.1	1.0	0.00	34.4	13.4	19.3	40.9	0.0	0.0	0.0	0.0	0.0	0.0
90-230	C	8.1	4.8	0.00	12.0	12.0	0.0	105.4	19.7	44.6	14.5	73.0	2.5	1.8
230-300	SIC	7.5	2.1	0.00	7.4	5.9	1.3	129.2	5.2	17.0	9.7	29.2	1.5	2.2
** SITE: 21	LOCATION: NE17-03-02W Series RGD													
0-90	C-CL	7.7	0.9	1.47	9.5	9.5	0.0	51.8	0.0	0.0	0.0	0.0	0.0	0.0
90-300	C	7.8	7.4	0.00	11.9	11.9	0.0	100.6	17.6	93.7	21.9	117.7	6.5	2.2
** SITE: 22	LOCATION: NW18-03-02W Series RIV													
0-20	C	8.0	8.7	0.45	7.4	5.9	1.3	94.0	17.4	83.2	51.8	136.1	7.7	2.3
200-300	C	8.3	8.5	0.00	6.7	4.0	2.4	141.0	20.4	79.3	49.6	129.6	8.9	2.4

SOIL WATER HOLDING CAPACITIES

Canada-Manitoba Soil Survey

The capacity of soils to absorb and retain water provides a reservoir from which water may be withdrawn by plants during periods between rainfalls and/or irrigations. That portion of the water held by a soil that plants can remove is referred to as "available water". The moist end of the range is defined by field capacity, the dry end by wilting point.

Field capacity is defined as the water content of a soil profile, usually the rooting zone, which has been thoroughly wetted by irrigation or rainfall and after the subsequent rate of drainage out of the profile has become negligibly small. A problem in using this concept is the difficulty in deciding when the rate of drainage from the soil profile has become negligibly small.

The permanent wilting point is defined as the water percentage of a soil at which plants growing in that soil are first reduced to a wilted condition from which they cannot recover in an approximately saturated atmosphere. Permanent wilting point is not strictly a property of the soil only, because some plants are more efficient than others in extracting soil water.

The following data is a summary of nine representative soils that were sampled in the R.M. of Rhineland for soil water holding properties.

Table 30. Soil Water Holding Capacities (2 Pages)

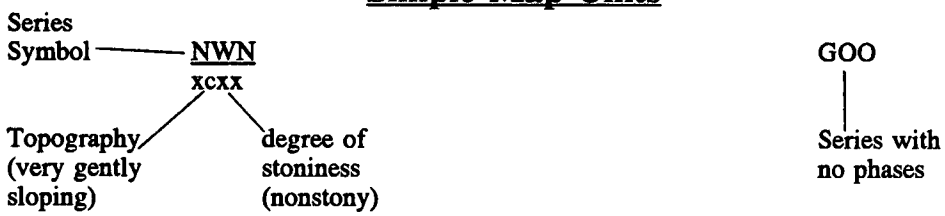
SOIL SERIES LOCATION	HORIZON	DEPTH (cm.)	ORGANIC CARBON (%)	CACO3 (%)	Particle Size (%) >02MM	VCS	CS	MS	FS	VFS	SAND	SILT	CLAY	TEXTURE CLASS	BULK DENSITY	WATER CONTENT (% BY WEIGHT) PWP	FC	AWC cc/cc	AVAIL WATER (mm)
NBG NEUENBERG	AP	0. 15.	2.31	6.30	0.	0.	0.	1.	4.	62.	67.	14.	19.	VFSL	1.28	6.76	23.60	0.22	32.
SW24-02-02W	AC	15. 30.	1.58	10.40	0.	0.	0.	0.	4.	59.	63.	16.	21.	SCL	1.48	8.47	21.50	0.19	29.
	CKGJ1	30. 60.	0.0	18.90	0.	0.	0.	0.	3.	65.	68.	14.	18.	VFSL	1.40	5.91	16.80	0.15	46.
	CKGJ2	60. 90.	0.0	21.90	0.	0.	0.	0.	6.	64.	70.	18.	12.	VFSL	1.49	4.05	13.50	0.14	42.
	CKGJ3	90. 120.	0.0	18.90	0.	0.	0.	1.	2.	60.	63.	28.	9.	VFSL	1.45	4.05	13.00	0.13	39.
																			188.
GDH GNADENTHAL	APK	0. 15.	3.00	2.80	0.	0.	0.	1.	2.	54.	57.	29.	14.	VFSL	1.17	7.62	24.50	0.20	30.
NW25-02-02W	AC	15. 30.	2.51	4.80	0.	0.	0.	1.	2.	50.	53.	25.	22.	SCL	1.32	8.62	24.50	0.21	31.
	CKGJ1	30. 61.	0.0	27.60	0.	0.	0.	1.	1.	36.	38.	33.	29.	CL	1.32	9.86	23.90	0.19	57.
	CKGJ2	61. 91.	0.0	27.20	0.	0.	0.	0.	1.	36.	37.	43.	20.	L	1.42	7.15	18.80	0.17	50.
	CKGJ3	91. 120.	0.0	16.40	0.	0.	0.	0.	1.	54.	55.	34.	11.	VFSL	1.47	3.74	13.60	0.14	42.
																			210.
NBG NEUENBERG	APK	0. 15.	2.43	5.80	0.	0.	0.	0.	4.	63.	67.	15.	18.	VFSL	1.43	7.15	22.90	0.23	34.
SE06-02-02W	AC	15. 30.	1.61	5.60	0.	0.	0.	0.	2.	67.	69.	14.	17.	VFSL	1.54	6.61	22.60	0.25	37.
	CKGJ1	30. 60.	0.0	18.10	0.	0.	0.	0.	2.	66.	68.	16.	16.	VFSL	1.43	5.83	17.60	0.17	50.
	CKGJ2	60. 90.	0.0	18.30	0.	0.	0.	0.	1.	75.	76.	14.	10.	VFSL	1.46	3.74	15.70	0.17	52.
	CKGJ3	90. 120.	0.0	20.70	0.	0.	0.	0.	1.	74.	75.	18.	7.	VFSL	1.49	3.04	14.00	0.16	49.
																			223.
NWN NEWTON SIDING	APK	0. 15.	2.95	10.50	0.	0.	0.	0.	1.	34.	35.	36.	29.	CL	1.13	9.71	27.70	0.20	30.
NW19-02-01W	APK	15. 29.	2.95	10.50	0.	0.	0.	0.	1.	34.	35.	36.	29.	CL	1.31	9.71	26.40	0.22	31.
	AC	29. 59.	1.11	21.80	0.	0.	0.	0.	1.	38.	39.	26.	35.	CL	1.27	8.62	24.70	0.20	61.
	CKGJ	59. 90.	0.0	24.90	0.	0.	0.	0.	1.	42.	43.	33.	24.	L	1.33	5.21	18.00	0.17	53.
	2CKGJ	90. 120.	0.0	17.80	0.	0.	0.	0.	0.	70.	70.	15.	15.	VFSL	1.37	3.43	17.40	0.19	57.
																			232.
GOO GLENMOOR	APK	0. 15.	2.70	18.90	0.	0.	0.	1.	3.	17.	21.	35.	44.	C	1.13	11.65	31.00	0.22	33.
SE25-03-01W	AC	15. 30.	0.52	43.00	0.	0.	0.	1.	1.	18.	20.	40.	40.	C	1.32	8.93	24.30	0.20	30.
	CKGJ	30. 60.	0.52	43.00	0.	0.	0.	1.	1.	18.	20.	41.	39.	CL	1.42	8.55	21.80	0.19	56.
	CKG1	60. 90.	0.0	38.40	0.	0.	0.	0.	1.	24.	25.	49.	26.	SIL	1.39	7.15	21.30	0.20	59.
	CKG2	90. 120.	0.0	38.40	0.	0.	0.	0.	1.	24.	25.	49.	26.	SIL	1.37	7.15	23.70	0.23	68.
																			247.
LKD LAKELAND	APK	0. 25.	2.98	16.40	0.	0.	0.	0.	1.	21.	22.	29.	49.	C	0.96	9.63	34.80	0.24	60.
SW24-01-01E	AC	25. 40.	1.12	32.40	0.	0.	0.	0.	1.	20.	21.	41.	38.	CL	1.35	8.24	29.40	0.29	43.
	CKGJ1	40. 60.	0.45	38.80	0.	0.	0.	0.	1.	23.	24.	44.	32.	CL	1.42	6.76	20.30	0.19	38.
	CKGJ2	60. 80.	0.0	35.90	0.	0.	0.	0.	0.	7.	7.	64.	29.	SICL	1.48	7.77	20.90	0.19	39.
	CKGJ3	80. 120.	0.0	38.50	0.	0.	0.	0.	0.	2.	2.	75.	23.	SIL	1.53	5.37	21.90	0.25	101.
																			282.

SOIL SERIES LOCATION	HORIZON	DEPTH (cm.)	ORGANIC CARBON (%)	CACO3 (%)	Particle Size (%) >02MM	VCS	CS	MS	FS	VFS	SAND	SILT	CLAY	TEXTURE CLASS	BULK DENSITY	WATER CONTENT (% BY WEIGHT) PWP	FC	AWC cc/cc	AVAIL WATER (mm)
GRA GRETNA	AP	0. 16.	4.16	0.0	0.	0.	1.	1.	2.	4.	8.	49.	43.	SIC	0.90	17.30	43.80	0.24	38.
SW01-01-02W	BNTGJ	16. 29.	2.80	0.0	0.	0.	0.	0.	0.	5.	5.	46.	49.	SIC	1.22	20.09	42.60	0.27	36.
	BC	29. 61.	2.05	0.0	0.	0.	0.	0.	0.	4.	4.	37.	59.	C	1.15	20.17	41.90	0.25	80.
	CGJS	61. 90.	0.0	0.0	0.	0.	0.	0.	0.	2.	2.	33.	65.	C	1.12	22.19	43.70	0.24	70.
	CKGJ	90. 120.	0.0	7.50	0.	0.	0.	0.	0.	4.	4.	33.	63.	C	1.16	20.25	40.00	0.23	69.
																			292.
OBO OSBORNE	AP	0. 11.	3.33	0.0	0.	0.	0.	0.	0.	4.	4.	20.	76.	C	0.80	16.92	42.70	0.21	23.
SE25-03-01W	AH	11. 29.	2.24	0.0	0.	0.	0.	0.	0.	4.	4.	20.	76.	C	1.21	16.37	38.00	0.26	47.
	AC	29. 59.	1.14	6.00	0.	0.	0.	0.	0.	3.	3.	16.	81.	C	1.25	16.37	37.60	0.27	80.
	CKG1	59. 90.	0.0	6.00	0.	0.	0.	0.	0.	3.	3.	16.	81.	C	1.29	16.37	35.50	0.25	76.
	CKG2	90. 120.	0.0	12.60	0.	0.	0.	0.	0.	3.	3.	17.	80.	C	1.30	15.13	34.00	0.25	74.
																			299.
DCS DENCROSS	APK	0. 30.	3.89	3.60	0.	0.	0.	1.	1.	9.	11.	38.	51.	C	1.19	11.18	35.80	0.29	88.
NE13-01-01E	BMGJ	30. 45.	1.69	1.50	0.	0.	0.	0.	0.	10.	10.	43.	47.	SIC	1.37	9.55	27.30	0.24	36.
	CCA	45. 70.	0.67	49.10	0.	0.	0.	0.	0.	8.	8.	49.	43.	SIC	1.41	9.17	26.60	0.25	61.
	CKGJ	70. 120.	0.0	37.30	0.	0.	0.	0.	0.	3.	3.	70.	27.	SICL	1.51	5.99	25.10	0.29	144.
																			330.

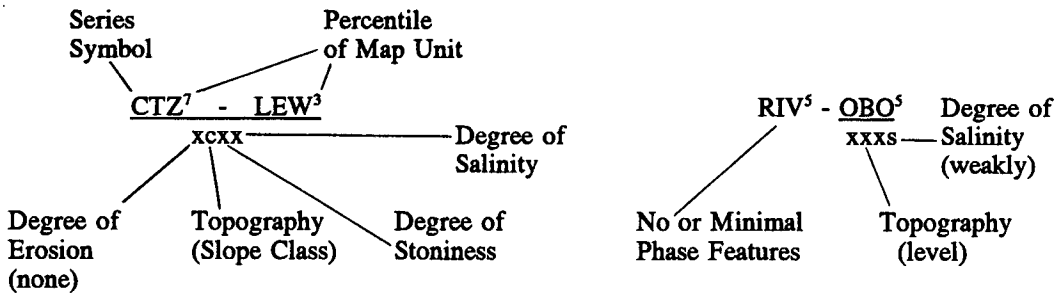
APPENDIX G

MAP UNIT SYMBOLOGY

Simple Map Units



Compound Map Units



In a compound unit where two series share the same denominator, the phases apply to both series accordingly.

Phases

Degree of Erosion

- x noneroded or minimal
- 1 slightly eroded
- 2 moderately eroded
- 3 severely eroded
- o overblown

Slope Class

- x 0-2% level to nearly level
- c 2-5% very gently sloping
- d 5-9% gently sloping
- e 9-15% moderately sloping
- f 15-30% strongly sloping
- g 30-45% very strongly sloping
- h 45-70% extremely sloping

Stoniness

- x nonstony
- 1 slightly stony
- 2 moderately stony
- 3 very stony
- 4 exceedingly stony
- 5 excessively stony

Degree of Salinity
Cond. (mS/cm)

- x non-saline 0-4
- s weakly saline 4-8
- t moderately saline 8-15
- u strongly saline 15+

Variants

Variants included are subdivisions of a series based on slight variation in surface (15-25 cm) texture.

1 = Loam to Clay Loam Variant
2 = Clay Variant

Example: DHO_1, GDH_2

- Deadhorse, loam to clay loam surface
- Gnadenthal, clay surface

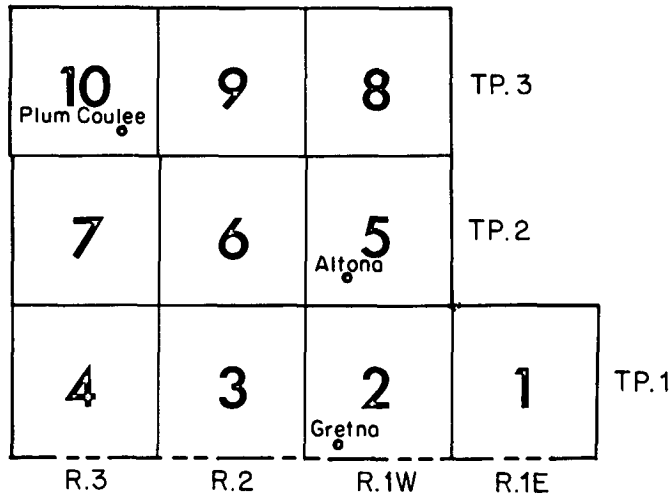
Soil Legend for R.M. OF RHINELAND

Soil Symbol	Soil Name	Surface Texture	Soil Drainage	Mode of Deposition	Family Particle Size	Subgroup
BCK	Black Lake	C	WELL	Fluvial	Clayey	CU.R
BKA	Birkenhead	LS	WELL	Fluviolacustrine	Sandy Skeletal	CA.BL
BMG	Blumengart	C	IMPER	Fluvial	Clayey	GLCU.R
BNF	Blumenfeld	L	POOR	Lacustrine	Loamy	R.HG
BUM	Blumenort	C	POOR	Fluvial	Clayey	R.HG
CTZ	Chortitz	CL	IMPER	Fluvial	Loamy	GLCU.R
DCS	Dencross	C	IMPER	Lacustrine	Clayey/Loamy	GLR.BL
DFS	Dufresne	C	POOR	Fluvial	Clayey	R.HG
DGS	Dugas	C	IMPER	Lacustrine	Clayey/Coarse Loamy	GLR.BL
DGS1	Dugas, var.	L-CL	IMPER	Lacustrine	Clayey/Coarse Loamy	GLR.BL
DHO	Deadhorse	C	IMPER	Lacustrine	Clayey	GLR.BL
DHO1	Deadhorse, var.	L-CL	IMPER	Lacustrine	Clayey	GLR.BL
DNH	Denham	L	WELL	Lacustrine	Loamy/Clayey	O.BL
EBG	Edenburg	CL	WELL	Lacustrine	Fine Loamy/Sandy	O.BL
EDK	Edkins	L	POOR	Lacustrine	Loamy/Clayey	R.HG
EGF	Eigenhof	CL	WELL	Lacustrine	Fine Loamy	O.BL
GDH	Gnadenthal	L	IMPER	Lacustrine	Loamy	GLR.BL
GDH2	Gnadenthal, var.	C	IMPER	Lacustrine	Loamy	GLR.BL
GOO	Glenmoor	C	POOR	Lacustrine	Clayey/Loamy	R.HG
GRA	Gretna	C	IMPER	Lacustrine	Very Fine Clayey	GL.SZ.BL
GYV	Graysville	L	IMPER	Lacustrine	Loamy/Clayey	GLR.BL
HDN	Hoddinott	C	IMPER	Lacustrine	Clayey/Loamy	GL.BL
HHF	Hochfeld	FSL	WELL	Lacustrine	Coarse Loamy	O.BL
HIN	Hibsin	FSL	WELL	Lacustrine	Coarse Loamy/Clayey	O.BL
HND	Horndean	C	IMPER	Lacustrine	Clayey/Coarse Loamy	GL.BL
HND1	Horndean, var.	L-CL	IMPER	Lacustrine	Clayey/Coarse Loamy	GL.BL
JOD	Jordan	C	WELL	Lacustrine	Clayey/Coarse Loamy	O.BL
JOD1	Jordan, var.	L-CL	WELL	Lacustrine	Clayey/Coarse Loamy	O.BL
JST	Jasset	VFSL	IMPER	Lacustrine	Loamy/Sandy	GL.BL
KOT	Kronstal	LVFS	IMPER	Lacustrine	Coarse Loamy	GL.BL

Soil Legend for R.M. OF RHINELAND

Soil Symbol	Soil Name	Surface Texture	Soil Drainage	Mode of Deposition	Family Particle Size	Subgroup
LEW	Loewen	CL	POOR	Fluvial	Loamy	R.HG
LKD	Lakeland	CL	IMPER	Lacustrine	Fine Loamy	GLR.BL
MRS	Morris	C	IMPER	Lacustrine	Clayey	GLSZ.BL
MYT	Myrtle	C	WELL	Lacustrine	Clayey	O.BL
NBG	Neuenberg	VFSL	IMPER	Lacustrine	Loamy/Sandy	GLR.BL
NUH	Neuhorst	CL	IMPER	Lacustrine	Fine Loamy	GLR.BL
NUH2	Neuhorst, var.	C	IMPER	Lacustrine	Fine Loamy	GLR.BL
NWN	Newton Siding	CL	IMPER	Lacustrine	Fine Loamy/Sandy	GLR.BL
NWN2	Newton Siding, var.	C	IMPER	Lacustrine	Fine Loamy/Sandy	GLR.BL
OBO	Osborne	C	POOR	Lacustrine	Clayey	R.HG
OWK	Osterwick	FSL	POOR	Lacustrine	Coarse Loamy	R.HG
PME	Plum Coulee	C	IMPER	Lacustrine	Clayey	GL.BL
PME1	Plum Coulee, var.	L-CL	IMPER	Lacustrine	Clayey	GL.BL
RBK	Rosebank	FSL	IMPER	Lacustrine	Sandy/Clayey	GLR.BL
RFD	Reinfeld	L	WELL	Lacustrine	Loamy	O.BL
RGD	Rignold	L	IMPER	Lacustrine	Loamy/Clayey	GL.BL
RIV	Red River	C	IMPER	Lacustrine	Clayey	GLR.BL
RLD	Reinland	FSL	IMPER	Lacustrine	Coarse Loamy	GLR.BL
RSG	Rosengart	VFSL	WELL	Lacustrine	Loamy/Sandy	O.BL
RWL	Rathwell	CL	IMPER	Lacustrine	Fine Loamy	GL.BL
SCY	Scanterbury	C	IMPER	Lacustrine	Clayey	GL.BL
SRE	Seine River	C	IMPER	Fluvial	Clayey	GLCU.R
WIK	Winkler	C	WELL	Lacustrine	Clayey	O.BL
WIK1	Winkler, var.	L-CL	WELL	Lacustrine	Clayey	O.BL

MAP SHEET INDEX



TOWNSHIP DIAGRAM

31	32	33	34	35	36
30	29	28	27	26	25
19	20	21	22	23	24
18	17	16	15	14	13
7	8	9	10	11	12
6	5	4	3	2	1